BONITRON

Solutions for AC Drives

Model M3345

Line Regeneration Module for AC Drives

Customer Reference Manual

Bonitron, Inc.
Nashville, TN



An industry leader in providing solutions for AC drives.

ABOUT BONITRON

Bonitron designs and manufactures quality industrial electronics that improve the reliability of processes and variable frequency drives worldwide. With products in numerous industries, and an educated and experienced team of engineers, Bonitron has seen thousands of products engineered since 1962 and welcomes custom applications.

With engineering, production, and testing all in the same facility, Bonitron is able to ensure its products are of the utmost quality and ready to be applied to your application.

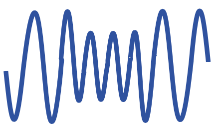
The Bonitron engineering team has the background and expertise necessary to design, develop, and manufacture the quality industrial electronic systems demanded in today's market. A strong academic background supported by continuing education is complemented by many years of hands-on field experience. A clear advantage Bonitron has over many competitors is combined on-site engineering labs and manufacturing facilities, which allows the engineering team to have immediate access to testing and manufacturing. This not only saves time during prototype development, but also is essential to providing only the highest quality products.

The sales and marketing teams work closely with engineering to provide up-to-date information and provide remarkable customer support to make sure you receive the best solution for your application. Thanks to this combination of quality products and superior customer support, Bonitron has products installed in critical applications worldwide.

AC Drive Options

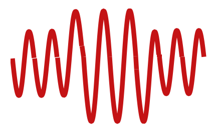
In 1975, Bonitron began working with AC inverter drive specialists at synthetic fiber plants to develop speed control systems that could be interfaced with their plant process computers. Ever since, Bonitron has developed AC drive options that solve application issues associated with modern AC variable frequency drives and aid in reducing drive faults. Below is a sampling of Bonitron's current product offering.

World Class Products



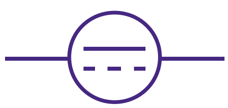
Undervoltage Solutions

Uninterruptible Power for Drives
(DC Bus Ride-Thru)
Voltage Regulators
Chargers and Dischargers
Energy Storage



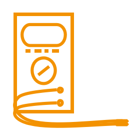
Overvoltage Solutions

Braking Transistors
Braking Resistors
Transistor/Resistor Combo
Line Regeneration
Dynamic Braking for Servo Drives



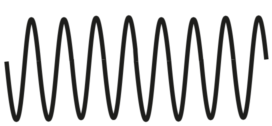
Common Bus Solutions

Single Phase Power Supplies
3-Phase Power Supplies
Common Bus Diodes



Portable Maintenance Solutions

Capacitor Formers
Capacitor Testers



Power Quality Solutions

12 and 18 Pulse Kits



Green Solutions

Line Regeneration

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1. INTRODUCTION

1.1. WHO SHOULD USE

This manual is intended for use by anyone who is responsible for integrating, installing, maintaining, troubleshooting, or using this equipment with any AC Drive System.

Please keep this manual for future reference.

1.2. PURPOSE AND SCOPE

This manual is a user's guide for the Model M3345 Line Regen Control modules. It provides you with the necessary information to successfully install and use the M3345 modules in your application.

In the event of any conflict between this document and any publication and/or documentation related to the application, the latter shall have precedence.

1.3. MANUAL VERSION AND CHANGE RECORD

Ratings Charts are updated in Rev 05a and Rev 05b.

Unit pictures and "C" chassis dimensions are updated in Rev 05c.

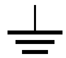
Torque terminology was changed in Rev 05d.

Update to the manual template in Rev 05e.

Figure 1-1: Typical M3345 Unit in the "S" and "B" Chassis



1.4. SYMBOL CONVENTIONS USED IN THIS MANUAL AND ON EQUIPMENT

	Earth Ground or Protective Earth
	AC Voltage
	DC Voltage
 DANGER!	DANGER: Electrical hazard - Identifies a statement that indicates a shock or electrocution hazard that must be avoided.
 DANGER!	DANGER: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.
 WARNING!	WARNING: Identifies information about actions or circumstances that will probably lead to property damage, personal injury or economic loss.
 CAUTION!	CAUTION: Identifies information about practices or circumstances that can lead to property damage, or economic loss.
 CAUTION!	CAUTION: Heat or burn hazard - Identifies a statement regarding heat production or a burn hazard that should be avoided.
 ATTENTION!	ATTENTION: Helps you identify a potential hazard, avoid a hazard, and recognize the consequences.

2. PRODUCT DESCRIPTION

The need for regenerated voltage control occurs when the frequency of an AC motor is greater than the frequency of the AC line or variable frequency drive providing power to the motor. In this case, the motor acts as a generator. The energy generated by a motor must be dissipated or returned to the power source. If this energy is not controlled, the motor may run with high voltage, the energy may be dissipated as heat in the motor, or the drive may trip on an overvoltage condition.

Bonitron's Model 3345 Regen Module is used for regeneration control of any AC drive system that uses a fixed bus system, such as the bus system used on AC PWM drives. The Regen module can pass the regenerated energy from the DC bus of the drive to the AC line. This provides for regulation of the DC bus and prevents the drives from tripping on overvoltage.

When a dynamic braking resistor is used with a PWM drive, the regenerated energy is dissipated as heat and energy is wasted. When the Model 3345 Regen Module is used, the regenerated energy is returned to the input AC line with near unity power factor. Substantial energy savings may occur as the regenerated energy can be used to power other equipment.

2.1. RELATED DOCS

COMMON BUS SHARING AND ISOLATION DIODES

- For applications with multiple drives
- M3345D, M3345CBM

BRAKING TRANSISTORS

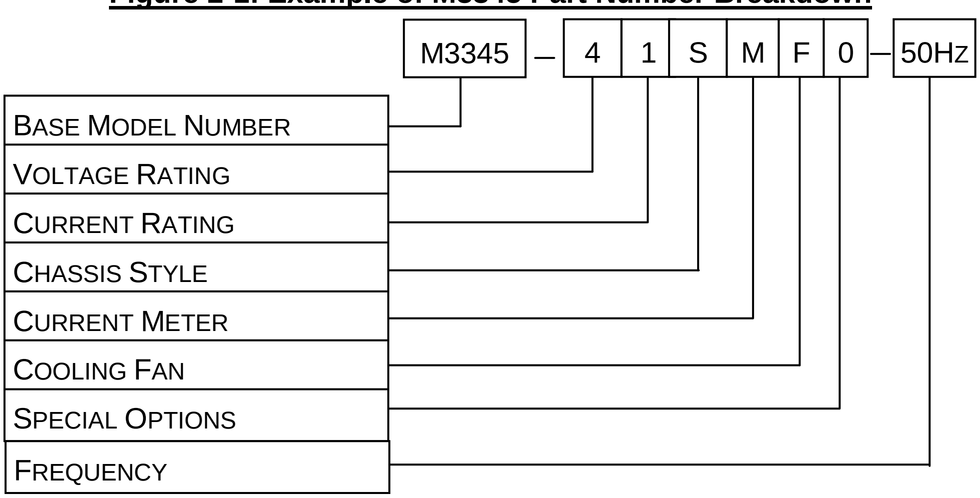
- For redundant operation with M3345 or for applications above 270A
- M3452, M3575T

BRAKING RESISTORS

- Used with Braking Transistors
- M3575R, M37775R

2.2. PART NUMBER BREAKDOWN

Figure 2-1: Example of M3345 Part Number Breakdown



Base Model Number

The Base Model Number for all Line Regen Controllers is **M3345**.

Voltage Rating

A 1 digit code represents the 3∅ AC line input voltage to the Regen module. The voltage rating must be selected for the system voltage that will be applied.

Table 2-1: Voltage Rating

Rating Code	Voltage
2	230 - 240VAC
3	380 - 415VAC
4	460 - 480VAC

Current Rating

A 1-digit code represents the maximum DC current which the Regen module can dissipate. This is an absolute maximum rating.

Table 2-2: Current Ratings

Rating Code	Current
0	10 Amps
1	20 Amps
2	30 Amps
4	45 Amps
A	60 Amps
5	90 Amps
6	120 Amps

Chassis Style

Table 2-3: Chassis Styles

Chassis Code	Description	Size (H x W x D)
S (10-45 Amps)	Type-1 enclosure	17.75” x 6.00” x 11.00”
B (10-45 Amps)	Type-13 JIC type wall mount enclosure	without fan: 17.50” x 16.25” x 8.25” with fan: 17.50” x 18.50” x 8.25”
X (10-45 Amps)	Open chassis, panel mount backplate	without fan: 15.00” x 15.10” x 8.50” with fan: 15.00” x 18.00” x 8.50”
Y (30-90 Amps)	Open chassis, panel mount backplate	16.00” x 20.00” x 11.00”
C (30-120 Amps)	Type-13 JIC type wall mount enclosure	26.50” x 16.00” x 11.25”
W (60-90 Amps)	Type-1 enclosure	20.00” x 10.00” x 10.50”
Z (60-120 Amps)	Open chassis, panel mount backplate	24.00” x 20.00” x 11.00”
V (120 Amps)	Type-1 enclosure	27.00” x 10.00” x 14.50”

Type-1 may also be known as ‘bookshelf’.

See Section 6.5 for chassis mounting and dimensional outlines.

CURRENT METER

An "M" in this position indicates the inclusion of a DC Regen current meter with the Regen module. A "0" in this position will omit the meter. A meter is provided as a standard part of all Type-13 JIC chassis modules and Type-1 chassis modules and is optional for all open-chassis modules.

COOLING FAN

An "F" in this position indicates the inclusion of a cooling fan with the Regen module. A "0" in this position will omit the cooling fan. A cooling fan is provided as a standard part of all chassis types except for the "B" and "X" chassis modules; however the cooling fan is an available option for the "B" and "X" chassis modules. Please note that a Regen module's rating is somewhat dependant on the use of a cooling fan. Refer to the tables in Section 6 of this manual to determine if a cooling fan is required for your application.

SPECIAL OPTIONS

- A "0" in this position indicates the unit is not Master / Slave selectable.
- An "M" in this position indicates the unit is 60A or higher and is Master / Slave selectable.

ATTENTION!

*Units with current ratings of 60-90 Amps **will** support Master/Slave operation. Units with current ratings of 10-45 Amps, and of 120 Amps **will not** support Master/Slave operation.*

FREQUENCY

- If the unit is for use on 60Hz systems, omit this position.
- 50Hz in this position indicates the unit is for use on 50Hz systems.

2.3. GENERAL SPECIFICATIONS CHART

Table 2-4: General Specifications

PARAMETER	SPECIFICATION
Connections	Input AC Line • Three Phase • Rated Voltage ±10% • 50Hz or 60Hz Drive DC Bus • 100% of rated DC current Ground
Power Factor	Greater than 90%
Current Limit	100% DC Rating
Operating Temp	0 to +40°C
Storage Temp	-20 to +65 °C
Humidity	Below 90% Non-condensing
Atmosphere	Free of corrosive or conductive gas and dust
Status Indicators	Power Light Run Current Limit Overload Current Meter
I/O	Ready

2.4. GENERAL PRECAUTIONS AND SAFETY WARNINGS

DANGER!

- HIGH VOLTAGES MAY BE PRESENT!
- NEVER ATTEMPT TO OPERATE THIS PRODUCT WITH THE ACCESS DOORS OR COVERS OPENED!
- NEVER ATTEMPT TO SERVICE THIS PRODUCT WITHOUT FIRST DISCONNECTING POWER TO AND FROM THE UNIT!
- **FAILURE TO HEED THESE WARNINGS MAY RESULT IN SERIOUS BODILY INJURY OR DEATH!**

CAUTION!

- THIS PRODUCT WILL GENERATE HIGH AMBIENT TEMPERATURES DURING OPERATION.
- THIS PRODUCT SHOULD BE INSTALLED ON A NON-FLAMMABLE SURFACE WITH CLEARANCES OF AT LEAST TWO INCHES IN ALL DIRECTIONS.
- ALWAYS ALLOW AMPLE TIME FOR THE UNIT TO COOL BEFORE ATTEMPTING SERVICE ON THIS PRODUCT.
- BEFORE ATTEMPTING INSTALLATION OR REMOVAL OF THIS PRODUCT, BE SURE TO REVIEW ALL DRIVE AND/OR RESISTIVE LOAD DOCUMENTATION FOR PERTINENT SAFETY PRECAUTIONS.
- INSTALLATION AND/OR REMOVAL OF THIS PRODUCT SHOULD ONLY BE ACCOMPLISHED BY A QUALIFIED ELECTRICIAN IN ACCORDANCE WITH NATIONAL ELECTRICAL CODE OR EQUIVALENT REGULATIONS.

ANY QUESTIONS AS TO APPLICATION, INSTALLATION OR SERVICE SAFETY SHOULD BE DIRECTED TO THE EQUIPMENT SUPPLIER.

3. INSTALLATION INSTRUCTIONS

CAUTION! *Installation and/or removal of this product should only be performed by a qualified electrician in accordance with National Electrical Code or local codes and regulations.*

Proper installation of the M3345 Regen Modules should be accomplished following the steps outlined below. Be sure to refer to the AC Drive instruction manual as these steps are performed. Please direct all installation inquiries that may arise during the installation and start up of this product to the equipment supplier or system integrator.

3.1. ENVIRONMENT

The module should be installed in an area protected from moisture and falling debris. Buildup of dust or debris may cause poor performance and possibly a failure. Operating in a wet environment can pose a shock hazard. The recommended temperature range for operating this module is 0 to +40°C.

3.2. UNPACKING

Upon receipt of this product, please verify that the product received matches the product that was ordered and that there is no obvious physical damage to the unit. If the wrong product was received or the product is damaged in any way, please contact the supplier from which the product was purchased.

3.3. MOUNTING

The installation site for the module should be chosen with several considerations in mind:

- When mounting Regen units in an enclosure, power dissipation should be taken into account. Refer to Section 6.2 Watt Loss for details.
- The unit requires a minimum clearance of two (2) inches in all directions around it when mounted near a non-heat source.
- Unit should not be exposed to falling debris or condensation.

Once the installation site has been selected as outlined above, the unit should be mounted in place.

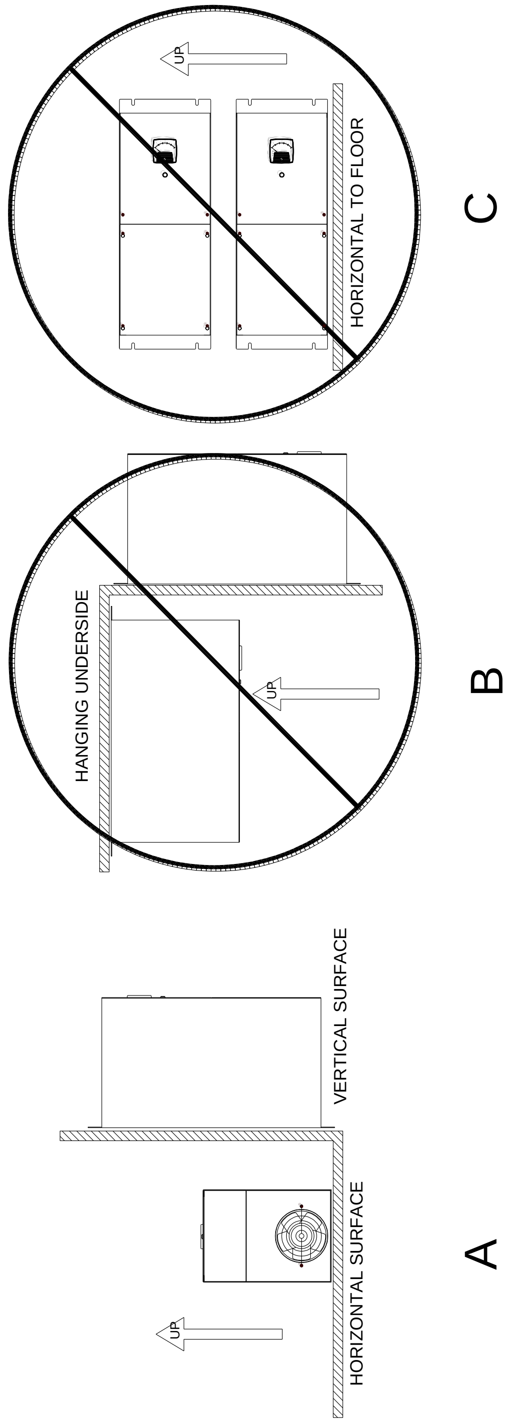
The M3345 must be properly oriented for proper heat flow through the unit. The M3345 must be mounted with the rear surface of the unit to the mounting surface. Unit may be mounted vertically or horizontally as shown in Figure 3-1A.

Do Not mount the unit in an upside-down position or on the underside of a mounting surface as shown in Figure 3-1B.

Do Not mount the unit in a horizontal position with its side parallel to the mounting surface or floor as shown in Figure 3-1C.

Refer to Table 2-3: Chassis Styles in Section 2.2 of this manual to determine the chassis for the unit. Mounting dimensions and provisions vary by unit chassis. See Figure 3-1 for Mounting Orientation information and Section 6.5 for dimensional drawings.

Figure 3-1: M3345 Mounting Orientation



3.4. WIRING AND CUSTOMER CONNECTIONS

Be sure to review all pertinent AC Drive and system documentation as well as the information listed below before proceeding. Connection points and terminal numbers of the AC drive will be found in the documentation provided with those units. See Tables 3-1 thru 3-6 and Figures 3-2 thru 3-11 for connection details.

3.4.1. POWER WIRING

WARNING!

Only qualified electricians should perform and maintain the interconnection wiring of this product. All wiring should be in accordance with local codes.

- Where possible, minimize the wire length between the Regen and the Drive. The wire length should not exceed 10'.
- Avoid routing and bundling the Regen AC/DC wire with the Drive AC PWM motor output wiring.

3.4.1.1. 3 PHASE AC INPUT

The AC input should be connected to a 3-phase source following the typical guidelines used when sizing for an inverter. This will insure sufficient source impedance to return power to the grid. Do not install chokes or reactors between the regen and the power source. If the AC drive requires a line reactor, the Regen should be connected to the utility grid side.

If an isolation transformer is to be used, the regen AC input **MUST** be connected to the same point as the drive AC input.

Do not connect to a generator unless minimum load at any time exceeds the peak expected regen power.

The regen units are not phase sensitive.

Insure that the frequency of the unit is correct when ordered, and only use 60Hz units on 60Hz systems, 50Hz units on 50Hz systems. This frequency is specified when the unit is ordered, and cannot be changed in the field.

WARNING!

Installing 50Hz regen units on 60Hz systems may cause severe damage to the regen unit.

3.4.1.2. DC BUS INPUT

The DC bus input may be connected to the DC bus of an AC drive, the DC output of a diode sharing unit, or to a common DC bus. If a reactor or choke are being used in the bus, make sure the actual connection is in parallel with filter capacitors of the drive/inverter.

WARNING!

Never attach the DC bus input of the M3345 to braking terminals on the AC drive, commonly marked "BR". These terminals are intended for use with an external resistor, and are not directly connected to the bus filter capacitors of the drive. Damage may occur if these terminals are used.
Please refer to your AC drive manual or AC drive Technical Support department for assistance with this connection.

3.4.1.3. GROUNDING

Using the ground stud provided, ground the chassis in accordance with local codes. Typically the wire gauge will be the same as is used to ground the attached drive.

Table 3-1: Power Terminal Specifications – 10 to 45 Amp Chassis

TERMINALS	FUNCTION	ELECTRICAL RATINGS	WIRE SIZE	TORQUE
L1, L2, L3	Power Input	45A 230/460VAC	#10-32 screw	20 lb-in
+ –	DC Bus Input	45A 750VDC	#10-32 screw	20 lb-in
GND	Chassis Ground		#10-32 screw	20 lb-in

Table 3-2: Power Terminal Specifications – 60 & 90 Amp Chassis

TERMINALS	FUNCTION	ELECTRICAL RATINGS	WIRE SIZE	TORQUE
L1, L2, L3	Power Input	90A 230/460VAC	5/16” stud	100 lb-in
+ –	DC Bus Input	90A 750VDC	5/16” stud	100 lb-in
GND	Chassis Ground		5/16” stud	100 lb-in

Table 3-3: Power Terminal Specifications – 120 Amp Chassis

TERMINALS	FUNCTION	ELECTRICAL RATINGS	WIRE SIZE	TORQUE
L1, L2, L3	Power Input	120A 230/460VAC	3/8” stud	182 lb-in
+ -	DC Bus Input	120A 750VDC	3/8” stud	182 lb-in
GND	Chassis Ground		5/16” stud	100 lb-in

3.4.2. I/O WIRING

M3345 Line Regens come with a status contact. See Table 3-6 for Master/Slave I/O terminals.

3.4.2.1. STATUS CONTACT

This is an isolated normally open contact. Contact will energize closed upon ready condition of unit. Contact is rated for 120V AC/DC @ 2 amps. See Section 4.2.4 for more information.

Table 3-4: I/O Terminal Specifications – S Chassis

TERMINAL	FUNCTION	ELECTRICAL RATINGS	WIRE SIZE	TORQUE
TS1-1	Ready Contact Common	2A - 120V resistive	28-16 AWG	2 lb-in
TS1-2	Ready Contact No Connection			
TS1-3	Ready Contact N.O.	2A – 120V resistive	28-16 AWG	2 lb-in

Table 3-5: I/O Terminal Specifications – B and X Chassis

TERMINAL	FUNCTION	ELECTRICAL RATINGS	WIRE SIZE	TORQUE
TB4-1	Ready Contact N.C.	2A - 120V resistive	18-12 AWG	4.5 lb-in
TB4-2	Ready Contact N.O.	2A - 120V resistive	18-12 AWG	4.5 lb-in
TB4-3	Ready Contact Common	2A - 120V resistive	18-12 AWG	4.5 lb-in

3.4.2.2. MASTER / SLAVE I/O

Units that are rated 60 amps and greater are provided with Master / Slave I/O terminals for parallel operation. See Figure 3-11 and Section 4.2.5 for more information.

Reference Table 3-6 when the unit is configured for Master.

Table 3-6: I/O Terminal Specifications – Y, C, W, Z, and V Chassis

TERMINAL	FUNCTION	ELECTRICAL RATINGS	WIRE SIZE	TORQUE
TS1-1 TS1-2	Master / Slave +	.5A – 250V	18-12 AWG	20 lb-in
TS1-3 TS1-4	Master / Slave -	.5A – 250V	18-12 AWG	20 lb-in
TS1-5***** TS1-6*****	Ready Contact NO	2A - 120V resistive	18-12 AWG	20 lb-in

*****Not standard in the “Y” chassis.

Figure 3-2: “S” Chassis Connections

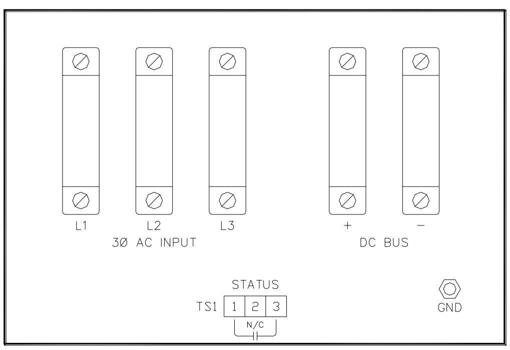


Figure 3-3: “W” Chassis Connections

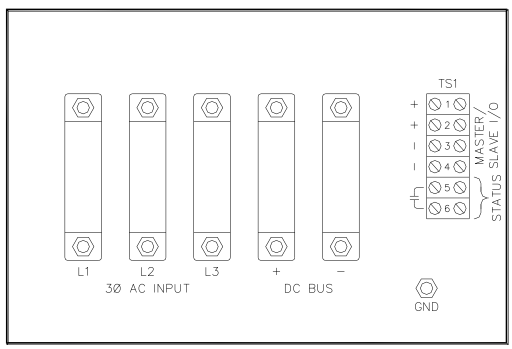


Figure 3-4: “V” Chx Conn.

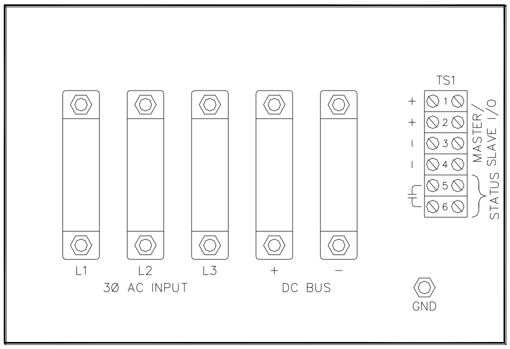


Figure 3-5: “X” and “B” Chx Conn.

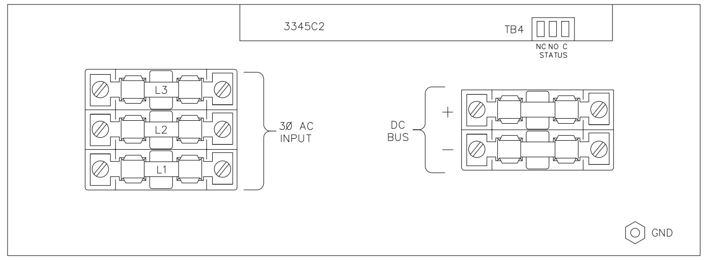


Figure 3-6: 60&90 Amp “C” Chx Conn.

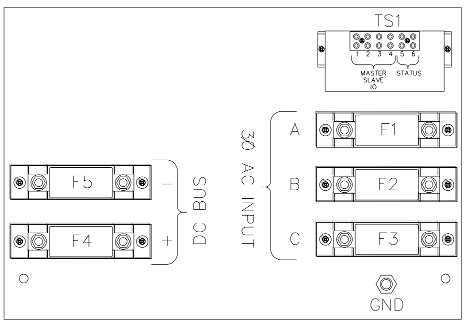


Figure 3-7: 120 Amp “C” Chx Conn.

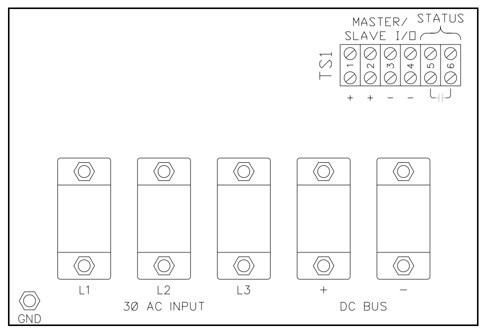
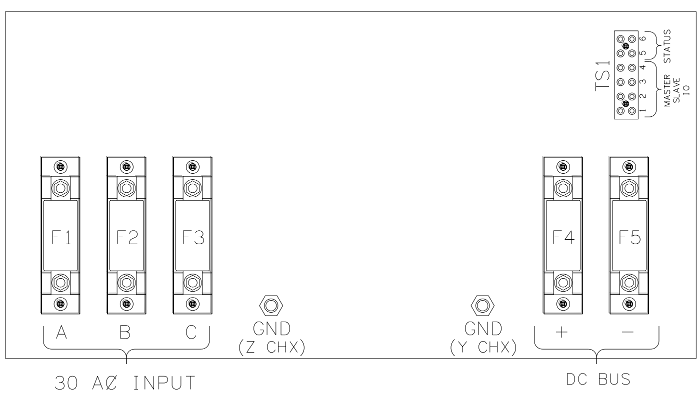


Figure 3-6: “Y” and “Z” Chassis Connections



3.5. TYPICAL CONFIGURATIONS

The diagrams shown in Figures 3-9 thru 3-11 illustrate typical connections of the M3345 Regen units with generic VFDs. There are many other configurations that may be applied providing a basic connection criterion is maintained such as:

- The AC input should maintain a low impedance path back to the grid.
- No reactors should be connected upstream of the regen unit without consulting Bonitron for instructions.

- The DC input should be connected to a fixed bus whether from a common bus supply or from the output of a VFD. This should never be connected to a switching source such as the braking resistor terminals on some drives.
- The DC input should not be connected to an active SCR front end drive without instructions from Bonitron.

Figure 3-7: M3345 10-120 Amp Single Drive / Regen Field Wiring Diagram

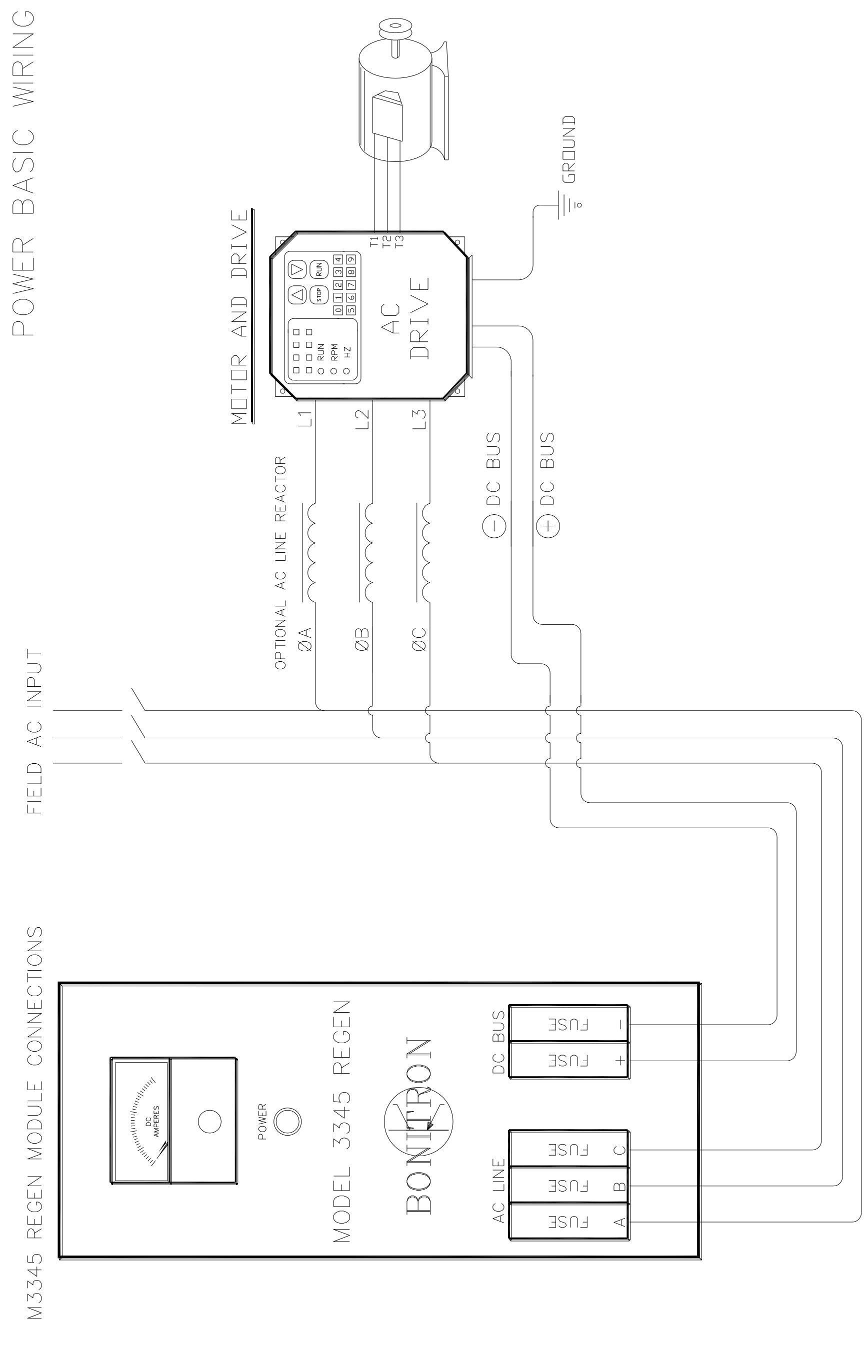
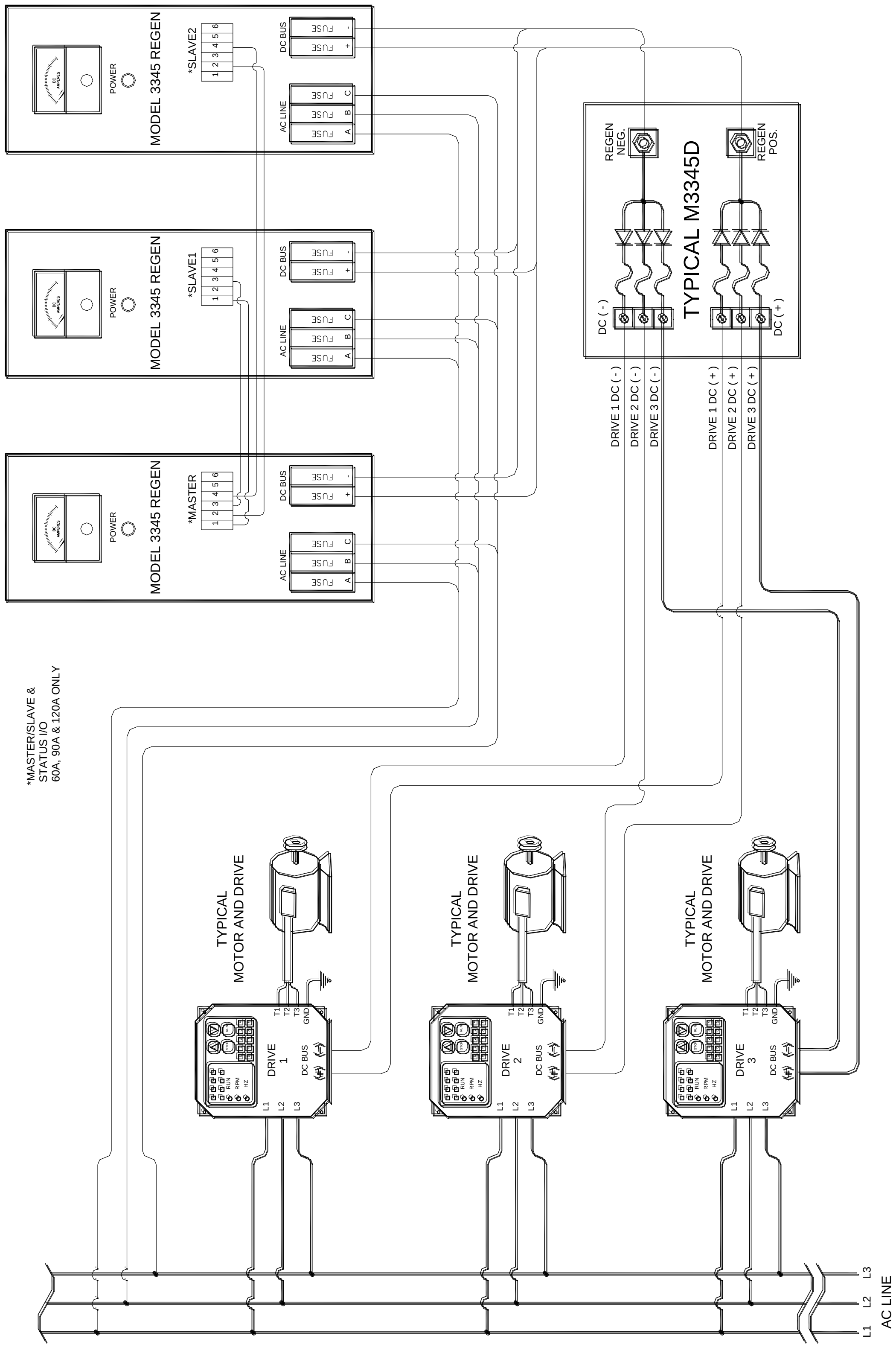


Figure 3-8: M3345 Multiple Drives/ Regens Field Wiring Diagram



Dwg: 950175 Rev: 20070522

Figure 3-9: M3345 Master Slave I/O Connection Diagram

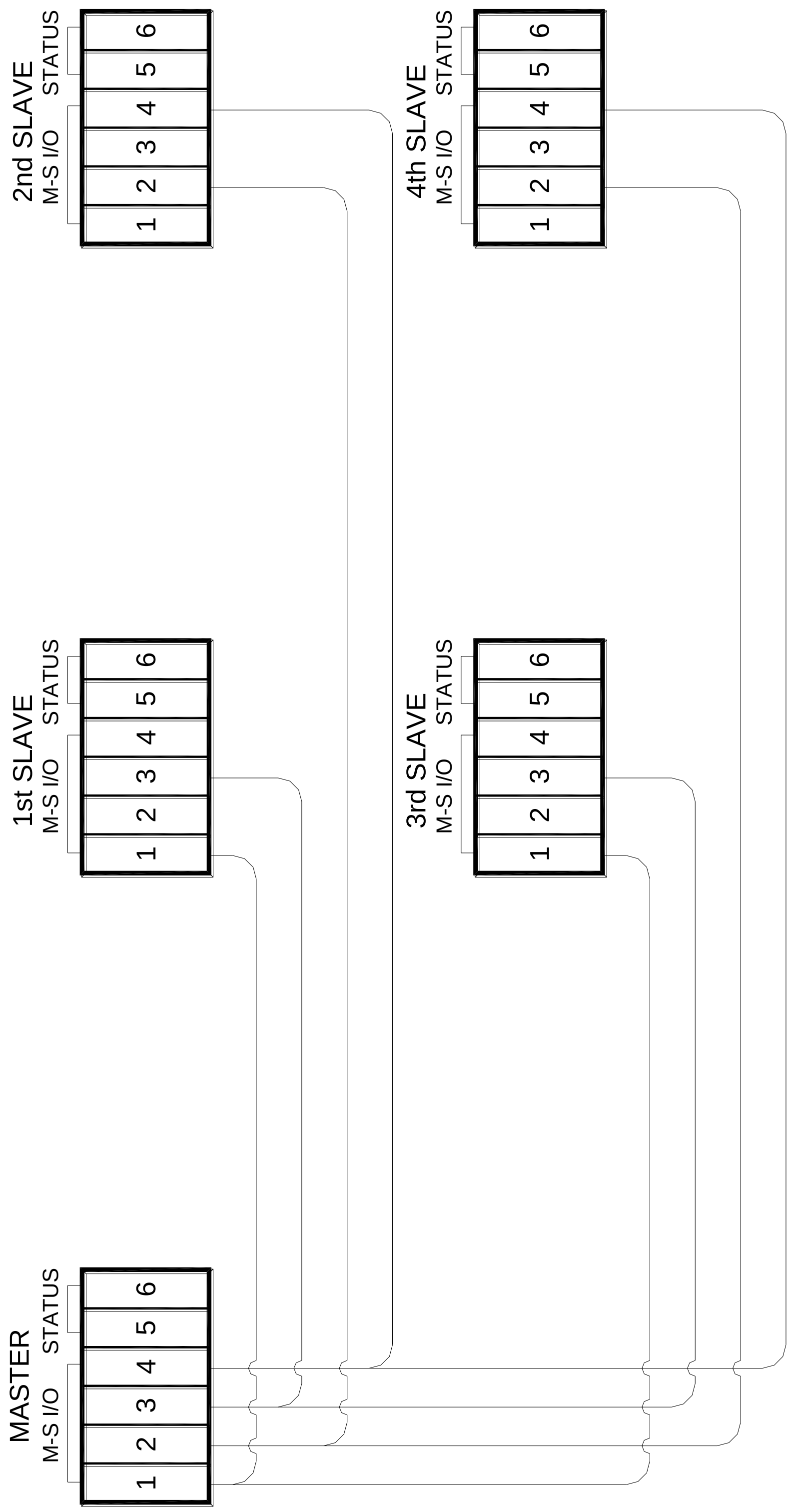
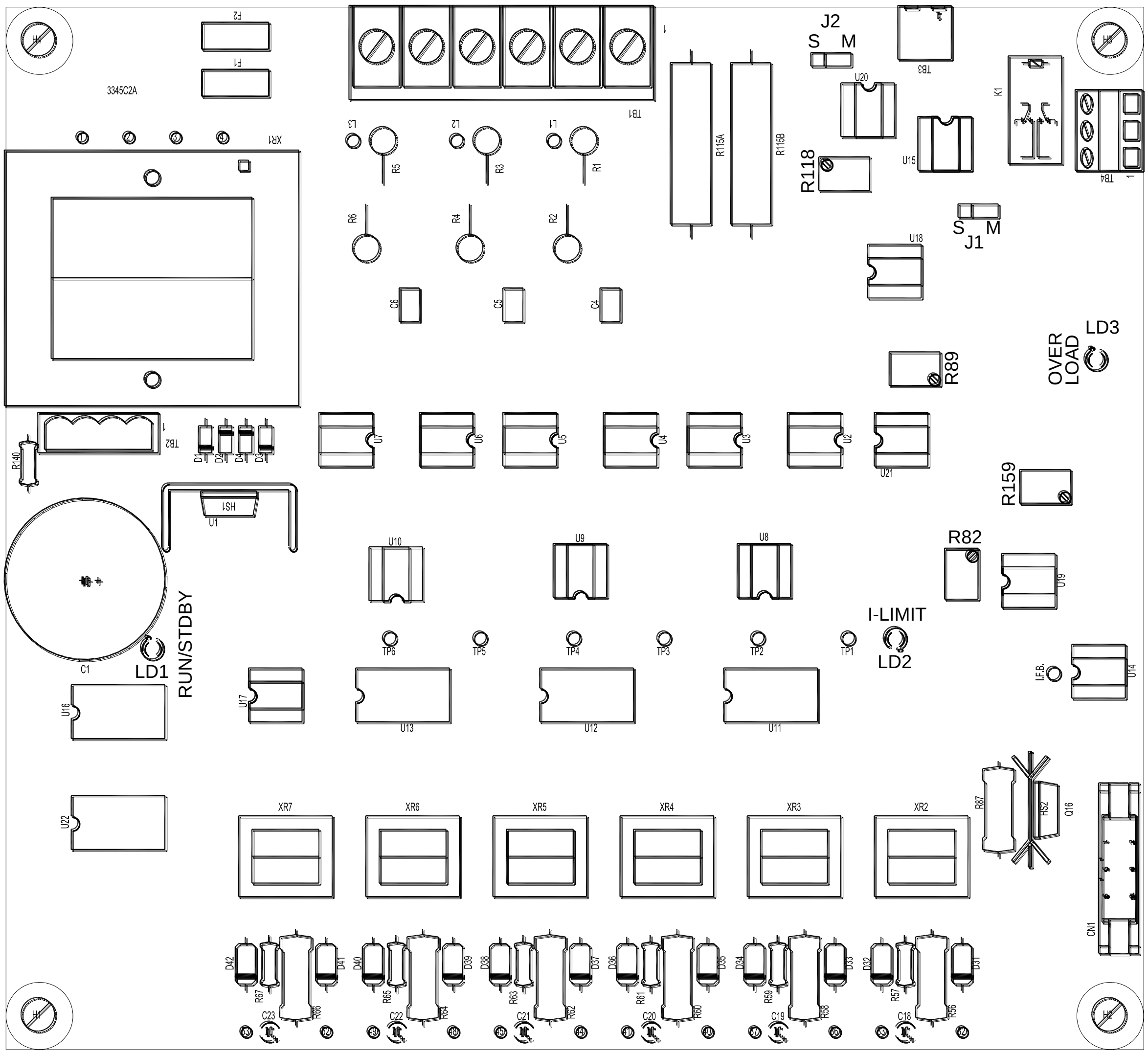


Figure 3-10: Control Board & Jumper Configuration

***For Single unit or Master operation J1 & J2 must be in the "M" position.
For Slave operation J1 & J2 must be in the "S" position.***



4. OPERATION

4.1. FUNCTIONAL DESCRIPTION

The M3345 Line Regen enables energy being generated by an over-hauling motor to be efficiently returned to the power grid. Alternative solutions typically consist of dissipating the returned energy in a resistor or simply allowing the motor to coast uncontrolled to a stop.

The M3345 Line Regen establishes a reference from the power source connected to the 3 phase input. This reference is used to establish the actual rectified DC voltage which is equal to the DC bus of the AC Drive in standby. The DC reference allows for conduction back to the AC line with limited rise in DC bus voltage. The reference is also used to monitor instantaneous changes in the incoming voltage.

Instantaneous changes in voltage greater than 15% can create an over-power condition for the power semiconductors. The M3345 will go into a shutdown mode during such events and resume operation upon return of nominal voltage. The M3345 will also go into the shutdown mode upon loss of any phase of the incoming power.

The M3345 series of Regen Modules come standard with an internal bus structure which allows for regeneration from the drive to the AC Line only. Power may be transferred from the AC drive to the regen; however, the regen will not provide energy to the AC drive.

4.2. FEATURES

- Fusing
- Internal line filtering
- Current metering
- Power indicator
- Status contact
- I/O for paralleling 60, 90, and 120 Amp units

4.2.1. FUSING

The M3345 Line Regen is provided with fusing for the AC input and the DC bus input. All fuses are fast semiconductor type and should only be replaced with original type. Please refer to Table 6-4 in Section 6.4.

4.2.2. INTERNAL LINE FILTERING

The M3345 series Line Regen incorporates internal filtering on the AC line to remove voltage transients created by the internal transistors. It also adds additional filtering to noise and harmonics that may be generated outside of the regen. The internal filtering is not intended for filtering external harmonics and if there are any known power quality issues extra attention should be given when startups are performed.

4.2.3. INDICATORS

4.2.3.1. CURRENT METERING

The M3345 Line Regen may come with an ammeter installed. This is an averaging meter which may not deflect the instantaneous current peaks which may be present.

4.2.3.2. POWER INDICATOR

The M3345 Line Regen comes standard with a neon power lamp. This lamp is powered by 2 of the 3 phases feeding the AC input.

CAUTION!

> *This lamp should not be relied upon for determining if voltage is present! Always check for voltage with dependable measuring device before attempting service on unit.*

4.2.4. STATUS CONTACT

The M3345 Line Regens come equipped with a status contact which may be integrated into system control I/O. This contact is normally open and energized closed when ready. The contact will open upon any of the following events:

- Loss of AC voltage
- Loss of any phase
- Instantaneous change in voltage
- Overload condition
- Over-temperature

This contact can be used for remote indication of the operation of the unit.

4.2.5. I/O FOR PARALLELING REGENS

The M3345 regeneration units come equipped with Master / Slave selectable control boards. 60 Amp and 90 Amp units are available for Master/Slave operations. The “S”, “B”, and “X” chassis units (< 60 Amp) do not provide I/O connections for Master / Slave operation. It is imperative that when paralleling units, one unit be configured as a Master and all others configured as Slaves. This will allow for up to 4 Slaves and 1 Master unit to be used in parallel operation. Refer to Figure 3-11 for connection diagram.

- Consult with Bonitron if you plan to configure more than 3 units as Slaves on the 60 & 90 Amp units.

When a unit is configured as Master, the terminals appear as outputs to the other units.

When the unit is configured as Slave, the terminals appear as inputs to the other units.

The signal is a complex waveform that is not reproducible as an analog input or output. The signal is floating with respect to ground, and could have a significant potential difference from other references.

WARNING!

> *Do not attempt to use these signals for any purpose other than interconnecting Bonitron M3345 units! Damage may occur to the M3345 as well as to the connected equipment!*

4.3. STARTUP

This section covers basic checks and procedures that should be used when performing a startup with a M3345 Line Regen.

4.3.1. PRE-POWER CHECKS

- Insure that the frequency of the AC power system is the same as the regen unit.
- Insure that the voltage of the AC power system is the same as the regen unit.
- Insure that all connections are tight and that all wiring is of the proper size and rating for operation.
- Verify continuity of all input fuses prior to applying power.
- Check for exposed conductors that may lead to inadvertent contact.
- Check for any debris, shavings, trimmings, etc that may cause shorts or obstruct ventilation on unit.

4.3.2. STARTUP PROCEDURE AND CHECKS

After completing Regen pre-checks and recommended checks for connected equipment you may apply power to the system. The power indicator on the front panel should illuminate and a small amount of current may be noticed on the ammeter. If the cover is open, the "RUN" LED should be illuminated on the 3345C2 control board (see Figure 3-12 for location). Status contact should be closed after a 2 second delay, which is an indication that unit is ready for operation. If any of the following conditions exist, refer to Troubleshooting in Section 5.3.

- Front panel lamp off with power applied.
- Status contact still open after 5 seconds.
- Excessive current flow in standby mode.

If none of the above conditions exist, the Regen Unit is now ready to operate, and the drive system can be run normally.

4.3.3. COOLING FAN

A heat sink cooling fan may be supplied as part of the Regen unit. The fan runs continuously when proper system voltage is present at the Regen unit inputs.

4.4. OPERATIONAL ADJUSTMENTS

WARNING!

Adjustments made outside of the factory settings can cause poor performance, reduced system capability, heatsink overheating, or even component failures. Under severe operating conditions, or if the settings have been accidentally or intentionally altered, some minor field adjustment may be required. Consult Bonitron prior to making any adjustments.

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5. Maintenance and Troubleshooting

Repairs or modifications to this equipment are to be performed by Bonitron approved personnel only. Any repair or modification to this equipment by personnel not approved by Bonitron will void any warranty remaining on this unit.

5.1. Periodic Testing

There are no requirements for periodic testing of these units. It may be beneficial to repeat start-up procedures and checks when performing routine maintenance.

5.2. Maintenance Items

Check the fan periodically for debris, and blow out with an air hose if it has become obstructed or not running at full capacity. **Power should not be applied when blowing dust and debris out of unit**.

5.3. Troubleshooting

CAUTION!

There are no user serviceable parts within the M3345 Regen unit. If you are still experiencing problems after you have reviewed this whole Section you may contact Bonitron for additional assistance at (615) 244-2825.

The 3345C2 Control Board has 3 LEDs which may be useful in diagnosing problems with the unit or system. The cover may need to be removed in order to access the control board. **Do not remove any covers with power applied to the unit!** Refer to Figure 3-12 for location of the LEDs on the circuit board. Following is a brief description of the LEDs and indications:

5.3.1. POWER Lamp is Out:

- Check AC input voltage at fuses
- Check voltage at output side of fuses
- Check connection to lamp from PCB

5.3.2. RUN Light is Out

The **RUN** LED indicates that the module is enabled and in a ready condition. This LED is directly related to the status contact at the I/O terminal. If the **RUN** LED is ON the status contact should be closed. If the LED is ON and the status contact does not change there is most likely a wiring issue. When the power is applied to the module, the **RUN** LED will normally come ON after a startup delay of approximately 2 seconds. Thereafter, the **RUN** LED should be ON, indicating that the system is ready to operate. If the **RUN** LED fails to come ON, one of several faults may be indicated.

- If the **OVERLOAD** LED is lit or briefly comes on other than at power-up, refer to Section 5.3.6.
- If no LEDs are lit, remove power and unplug TB2 and measure continuity of the purple and purple/tr wires on the connector. This should be 0 ohms. If connection measures open, the thermostat is either indicating high temperature or is defective. Switch opens at 175°F and closes at 140°F on all chassis EXCEPT the Y chassis

(where the switch opens at 140°F and closes at 110°F). If the unit is cool, the switch may be defective. Contact Bonitron for service.

- Check the ribbon cable connector CN1 to be securely plugged in.
- If thermostat measures OK, check the continuity of the wires feeding the 3 phase AC to the control board at TB1. The brown, yellow, and orange wires should be directly connected to the main input fuses.
- Verify the Dip Threshold as shown in Section 4.4.2.

5.3.3. STATUS CONTACT REMAINS OPEN AFTER A 5 SECOND DELAY

- Check AC input voltage at fuses to be within +/- 10% of nominal voltage
- If unit appears to be hot allow a few minutes to cool off
- If status contact does not change try cycling power to the unit

5.3.4. METER SHOWING EXCESSIVE CURRENT WHEN IN STANDBY (>3% RATED CURRENT)

- Measure AC input voltage to be balanced Line to Line
- If more than 5VAC difference, move highest pair to B & C
- Check for harmonics and noise on the AC that may be caused by DC drives, welders, induction heaters, etc.
- See Section 4.4 about adjustments and/or contact support at Bonitron

5.3.5. DRIVE TRIPS ON DC BUS OVERVOLTAGE

- Verify status contact, if open see Section 5.3.3
- Check DC bus voltage at fuses
- Check DC bus polarity at fuse
- Check DC bus fuses
- Ensure unit is not overheated
- Verify proper sizing of regen unit

5.3.6. OVERLOAD LIGHT IS FLICKERING

The normal state for the **OVERLOAD** LED is OFF. The **OVERLOAD** LED may flash for a brief moment on power-up. The **OVERLOAD** LED indicates that the system DC bus feedback is substantially greater than the DC bus reference signal. Under normal operating conditions, this occurs when the regenerated power from the drive is greater than the capacity of the regen module. When this occurs, the DC bus rise will cause the regen module to be temporarily disabled. With the module disabled, the drive DC bus will continue to rise until the Drive Overvoltage condition causes the drive to trip OFF. Once the Overvoltage condition ceases to exist, the **OVERLOAD** LED will turn OFF and the fault condition will be reset.

Since the drive and regen module have peak rectifier diode modules, a substantial line transient on the AC power lines can cause an erroneous **OVERLOAD** fault even in the standby mode.

5.3.7. CURRENT LIMIT LIGHT IS ON

The normal state for the **CURRENT LIMIT** LED is OFF. An ON state for the **CURRENT LIMIT** LED indicates that there is greater than 100% of the maximum limit of instantaneous, non-filtered, regenerated current in any 1 of the 3 AC input line feeds. The response of the **CURRENT LIMIT** LED is much quicker than the averaging DC bus ammeter frequently supplied with the regen module. The **CURRENT LIMIT** LED is informative when the

system operation consists of short but high peak currents. An ON state can indicate the presence of short energy surges which may cause an Overload condition.

5.3.8. TECHNICAL HELP – BEFORE YOU CALL

If technical help is required, please have the following information available when calling:

- Model number of unit
- Serial number of unit
- Name of original equipment supplier if available
- Record the Line to Line voltage on all 3 phases
- Record the DC bus voltage immediately after the AC voltage
- Brief description of the application
- Drive and motor hp or kW
- KVA rating of power source
- Source configuration Wye/Delta and grounding

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6. ENGINEERING DATA

6.1. RATINGS CHARTS

Table 6-1: Ratings and Specifications – 230VAC

MODEL NUMBERS	CHASSIS STYLE	DC REGEN		RATED HP		MAX WATT LOSS
		PEAK CURRENT	CONT. CURRENT	BRAKING	CONTINUOUS	
M3345-20SMF0	TYPE-1	10	10	2.3	2.3	436
M3345-20X*00	Open	10	6	2.3	1.3	287
M3345-20X*F0	Open	10	10	2.3	2.3	436
M3345-20BM00	TYPE-13	10	6	2.3	1.3	287
M3345-20BMF0	TYPE-13	10	10	2.3	2.3	436
M3345-21SMF0	TYPE-1	20	20	4.5	4.5	734
M3345-21X*00	Open	20	6	4.5	1.3	287
M3345-21X*F0	Open	20	20	4.5	4.5	734
M3345-21BM00	TYPE-13	20	6	4.5	1.3	287
M3345-21BMF0	TYPE-13	20	20	4.5	4.5	734
M3345-22SMF0	TYPE-1	30	20	6.8	4.5	734
M3345-22X*00	Open	30	6	6.8	1.3	287
M3345-22X*F0	Open	30	20	6.8	4.5	734
M3345-22BM00	TYPE-13	30	6	6.8	1.3	287
M3345-22BMF0	TYPE-13	30	20	6.8	4.5	734
M3345-22CMFM	TYPE-13	30	30	6.8	6.8	1107
M3345-22Y*F0	Open	30	30	6.8	6.8	1107
M3345-24SMF0	TYPE-1	45	30	10	7	1107
M3345-24X*00	Open	45	5	10	1	287
M3345-24X*F0	Open	45	20	10	4	734
M3345-24BM00	TYPE-13	45	5	10	1	287
M3345-24BMF0	TYPE-13	45	20	10	4	734
M3345-24CMFM	TYPE-13	45	45	10	10	1592
M3345-24Y*F0	Open	45	45	10	10	1592
M3345-2AWMFM	TYPE-1	60	55	14	12	1965
M3345-2AY*FM	Open	60	49	14	11	1741
M3345-2ACMFM	TYPE-13	60	55	14	12	1965
M3345-2AZ*FM	Open	60	55	14	12	1965
M3345-25WMFM	TYPE-1	90	55	20	12	1965
M3345-25Y*FM	Open	90	48	20	11	1741
M3345-25CMFM	TYPE-13	90	55	20	12	1965
M3345-25Z*FM	Open	90	55	20	12	1965
M3345-26VMFM	TYPE-1	120	81	27	18	2711
M3345-26CMFM	TYPE-13	120	81	27	18	2711
M3345-26Z0FM	Open	120	81	27	18	2711

* an "M" in this place denotes a Current Meter is included, a "0" indicates Current Meter is not included.

Table 6-2: Ratings and Specifications – 380VAC

MODEL NUMBERS	CHASSIS STYLE	DC REGEN		RATED HP		MAX WATT LOSS
		PEAK CURRENT	CONT. CURRENT	BRAKING	CONTINUOUS	
M3345-30SMF0	TYPE-1	10	10	7	7	436
M3345-30X*00	Open	10	6	7	4	287
M3345-30X*F0	Open	10	10	7	7	436
M3345-30BM00	TYPE-13	10	6	7	4	287
M3345-30BMF0	TYPE-13	10	10	7	7	436
M3345-31SMF0	TYPE-1	20	20	15	15	734
M3345-31X*00	Open	20	6	15	4	287
M3345-31X*F0	Open	20	20	15	15	734
M3345-31BM00	TYPE-13	20	6	15	4	287
M3345-31BMF0	TYPE-13	20	20	15	15	734
M3345-32SMF0	TYPE-1	30	20	22	15	734
M3345-32X*00	Open	30	6	22	4	287
M3345-32X*F0	Open	30	20	22	15	734
M3345-32BM00	TYPE-13	30	6	22	4	287
M3345-32BMF0	TYPE-13	30	20	22	15	734
M3345-32CMFM	TYPE-13	30	30	22	22	1107
M3345-32Y*F0	Open	30	30	22	22	1107
M3345-34SMF0	TYPE-1	45	30	33	23	1107
M3345-34X*00	Open	45	5	33	4	287
M3345-34X*F0	Open	45	20	33	15	734
M3345-34BM00	TYPE-13	45	5	33	4	287
M3345-34BMF0	TYPE-13	45	20	33	15	734
M3345-34CMFM	TYPE-13	45	45	33	33	1592
M3345-34Y*F0	Open	45	45	33	33	1592
M3345-3AWMFM	TYPE-1	60	55	45	41	1965
M3345-3AY*FM	Open	60	49	45	36	1741
M3345-3ACMFM	TYPE-13	60	55	45	41	1965
M3345-3AZ*FM	Open	60	55	45	41	1965
M3345-35WMFM	TYPE-1	90	55	67	41	1965
M3345-35Y*FM	Open	90	48	67	36	1741
M3345-35CMFM	TYPE-13	90	55	67	41	1965
M3345-35Z*FM	Open	90	55	67	41	1965
M3345-36VMFM	TYPE-1	120	81	89	60	2711
M3345-36CMFM	TYPE-13	120	81	89	60	2711
M3345-36Z0FM	Open	120	81	89	60	2711

* an “M” in this place denotes a Current Meter is included, a “0” indicates Current Meter is not included.

Table 6-3: Ratings and Specifications – 460VAC

MODEL NUMBERS	CHASSIS STYLE	DC REGEN		RATED HP		MAX WATT LOSS
		PEAK CURRENT	CONT. CURRENT	BRAKING	CONTINUOUS	
M3345-40SMF0	TYPE-1	10	10	9	9	436
M3345-40X*00	Open	10	6	9	5	287
M3345-40X*F0	Open	10	10	9	9	436
M3345-40BM00	TYPE-13	10	6	9	5	287
M3345-40BMF0	TYPE-13	10	10	9	9	436
M3345-41SMF0	TYPE-1	20	20	18	18	734
M3345-41X*00	Open	20	6	18	5	287
M3345-41X*F0	Open	20	20	18	18	734
M3345-41BM00	TYPE-13	20	6	18	5	287
M3345-41BMF0	TYPE-13	20	20	18	18	734
M3345-42SMF0	TYPE-1	30	20	27	18	734
M3345-42X*00	Open	30	6	27	5	287
M3345-42X*F0	Open	30	20	27	18	734
M3345-42BM00	TYPE-13	30	6	27	5	287
M3345-42BMF0	TYPE-13	30	20	27	18	734
M3345-42CMFM	TYPE-13	30	30	27	27	1107
M3345-42Y*F0	Open	30	30	27	27	1107
M3345-44SMF0	TYPE-1	45	30	41	27	1107
M3345-44X*00	Open	45	5	41	5	287
M3345-44X*F0	Open	45	20	41	18	734
M3345-44BM00	TYPE-13	45	5	41	5	287
M3345-44BMF0	TYPE-13	45	20	41	18	734
M3345-44CMFM	TYPE-13	45	45	41	41	1592
M3345-44Y*F0	Open	45	45	41	41	1592
M3345-4AWMFM	TYPE-1	60	55	54	50	1965
M3345-4AY*FM	Open	60	49	54	44	1741
M3345-4ACMFM	TYPE-13	60	55	54	50	1965
M3345-4AZ*FM	Open	60	55	54	50	1965
M3345-45WMFM	TYPE-1	90	55	81	50	1965
M3345-45Y*FM	Open	90	48	81	43	1741
M3345-45CMFM	TYPE-13	90	55	81	50	1965
M3345-45Z*FM	Open	90	55	81	50	1965
M3345-46VMFM	TYPE-1	120	81	108	73	2711
M3345-46CMFM	TYPE-13	120	81	108	73	2711
M3345-46Z0FM	Open	120	81	108	73	2711

* an "M" in this place denotes a Current Meter is included, a "0" indicates Current Meter is not included.

A NOTE ON HP RATINGS

The **Braking hp** rating is dependent on the transistors, diodes, snubbers, and fuses provided with the module. It is a function of the DC bus amp rating and indicates the maximum hp that the module is designed to dissipate. Modules are able to provide full **Braking hp** for at least **60 seconds**. Modules can provide less than full Braking hp for longer times.

The **Continuous hp** rating is a function of package style, heatsinks, and cooling fans. This rating is always equal to or less than the **Braking hp** rating. For applications the following must exist:

Continuous Regen hp rating ≥ Required hp rating * Duty Cycle

6.2. WATT LOSS

Tables 6-1 thru 6-3 list the maximum Watt/Loss generated by each of the listed Regen units. When installing Regen units in an additional enclosure, consideration should be given to internal temperature rise. The Watt/Loss rating in these tables is based upon the maximum regen capability of each unit. Applications that do not utilize the full capacity may be calculated as follows:

hp*746*5%+100 = Watt Loss

Where *hp* is the average estimated regen horsepower

6.3. CERTIFICATIONS

There are presently no certifications for the M3345 Regen Unit. If certification is required, check with your integrator and/or panel shop for full system certification. The M3345 is constructed with industry guidelines and safety taken into consideration. If information is required for certification please contact Bonitron with your request.

6.4. FUSE/CIRCUIT BREAKER SIZING AND RATING

- Only replace fuses with original type and rating.
- Due to the current limit control capability, blown fuses typically indicate internal device failure or severe transient absorption event.

Table 6-4: Replacement Fuses

REGEN MODULE CURRENT RATING	AC LINE INPUT REPLACEMENT FUSE	DC BUS OUTPUT REPLACEMENT FUSE
10 Amps	A60Q15	A60Q15
20 Amps	A60Q25	A60Q25
30 Amps (B, S, X chx)	A60Q30	FWP-40
30 Amps (C, Y, Z chx)	FWP-35	FWP-40
45 Amps (B, S, X chx)	A60Q40	FWP-50
45 Amps (C, Y, Z chx)	FWP-50	FWP-60
60 Amps	FWP-70	FWP-80
90 Amps	FWP-100	FWP-100
120 Amps	FWP-125	FWP-125

6.5. Dimensions and Mechanical Drawings

<u>Figure 6-1: M3345 "S" Chassis Dimensional Outline</u>

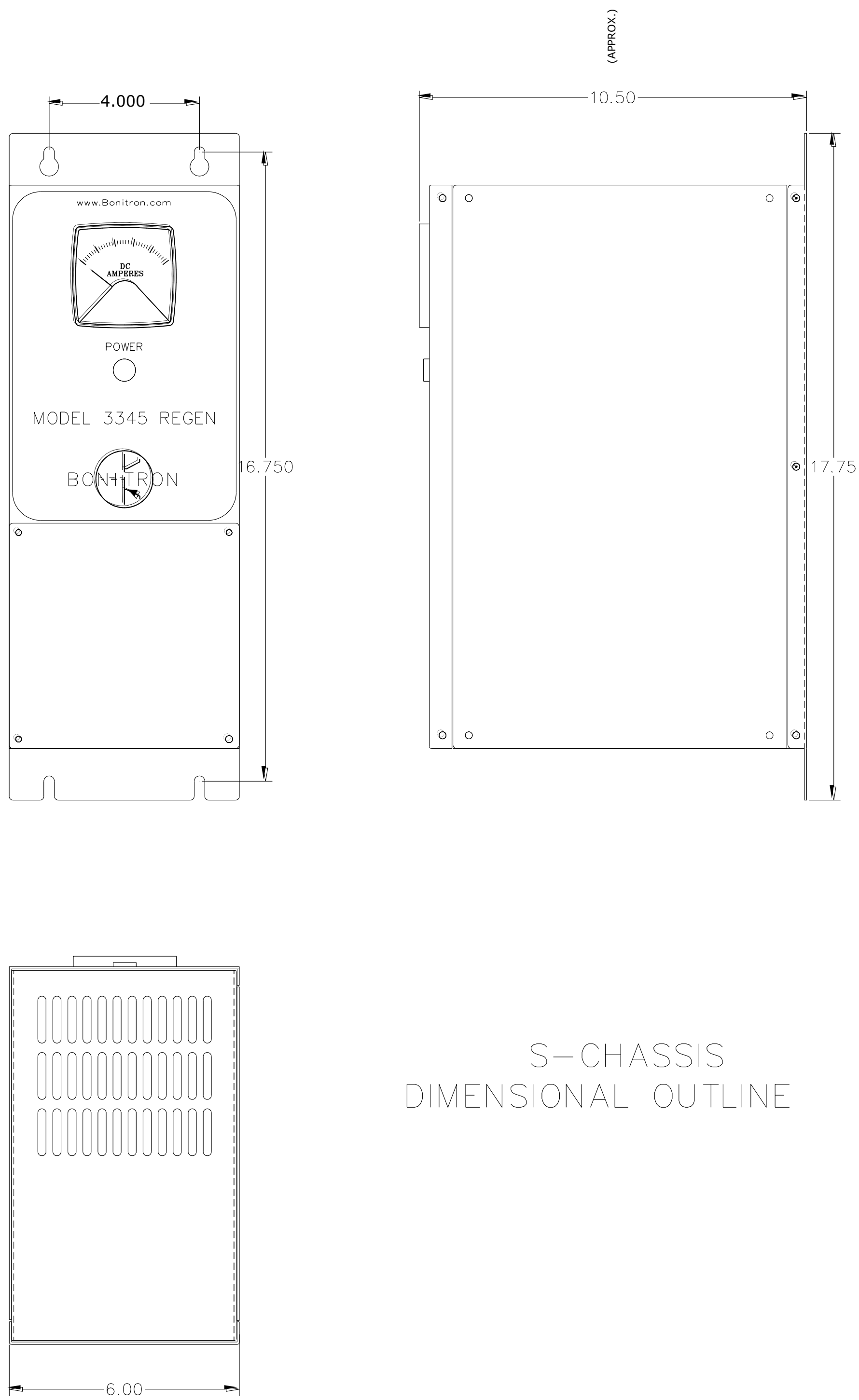


Figure 6-2: M3345 "W" Chassis Dimensional Outline

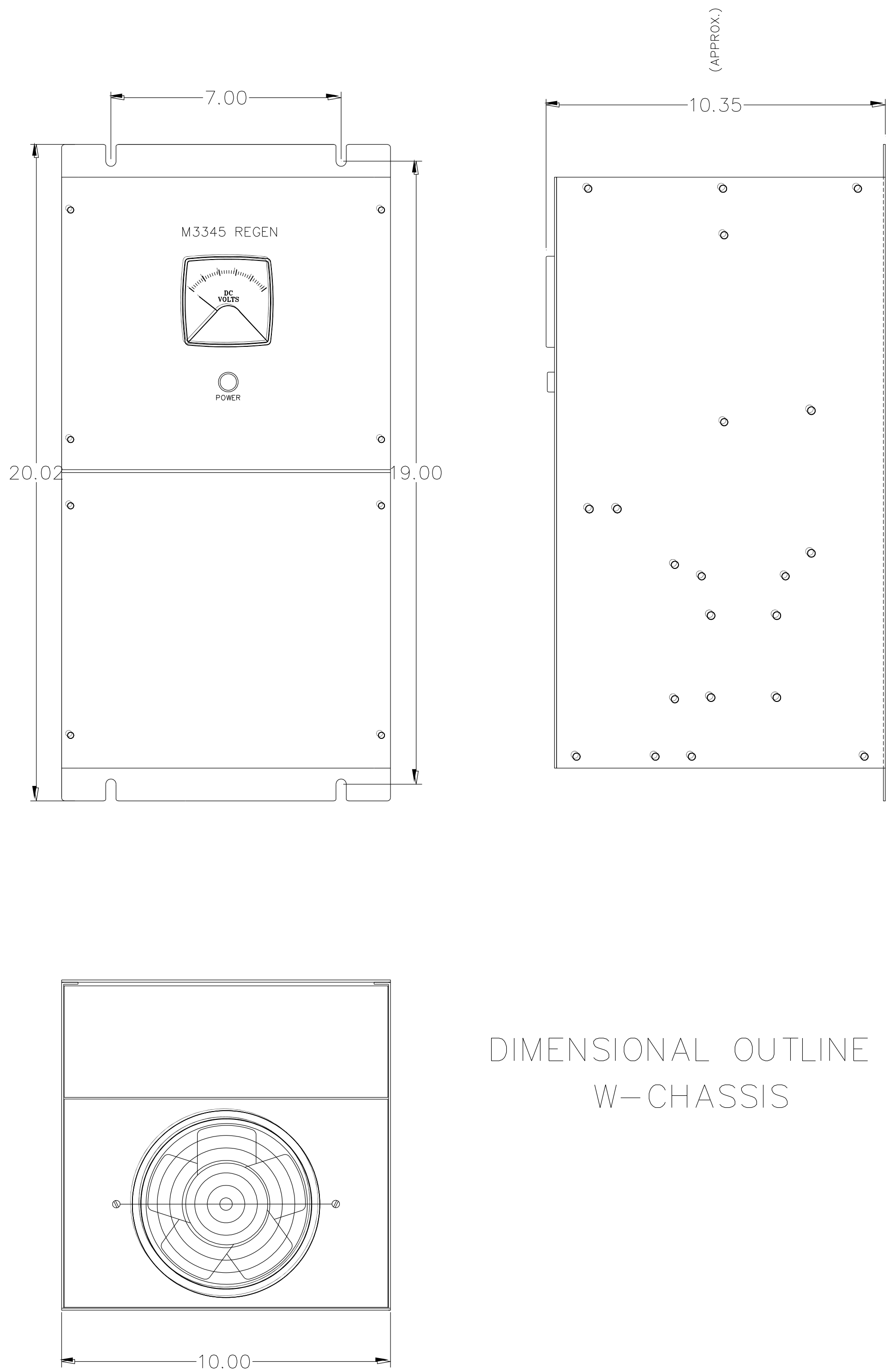


Figure 6-3: M3345 "V" Chassis Dimensional Outline

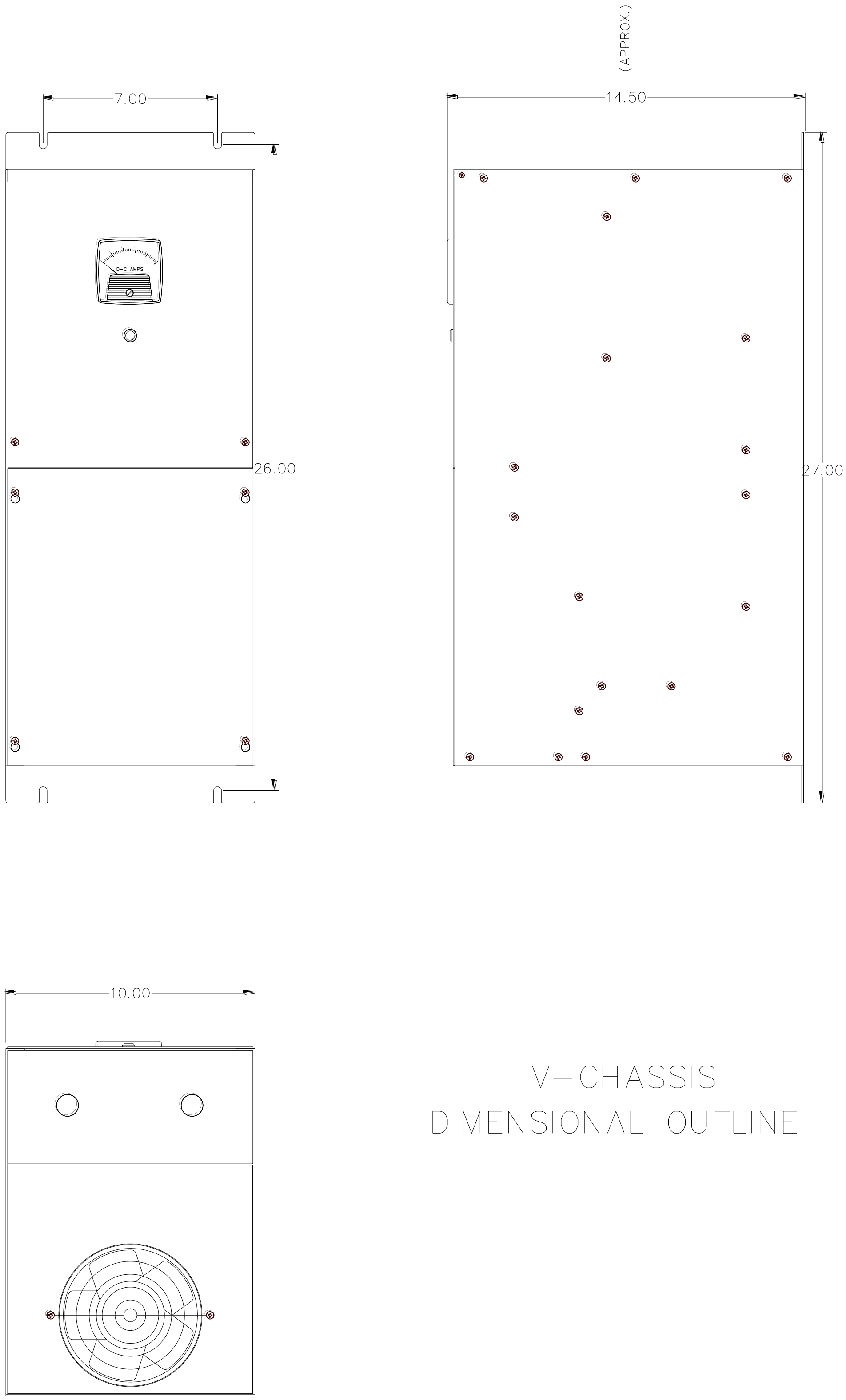
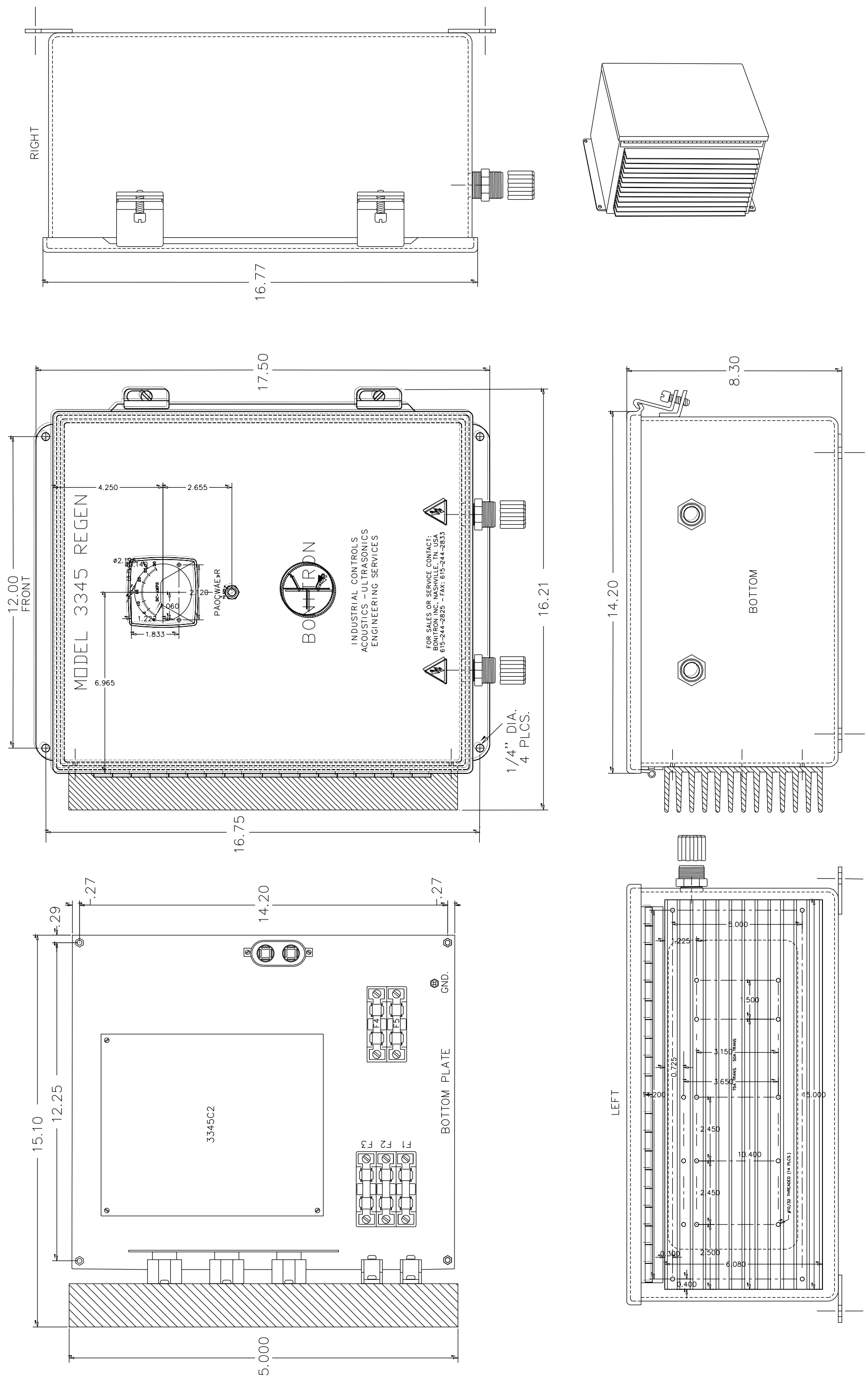


Figure 6-4: M3345 "B" Chassis Dimensional Outline



Dwg: 920306 Rev: 20080310

Figure 6-5: M3345 "B" Chassis with Fan Dimensional Outline

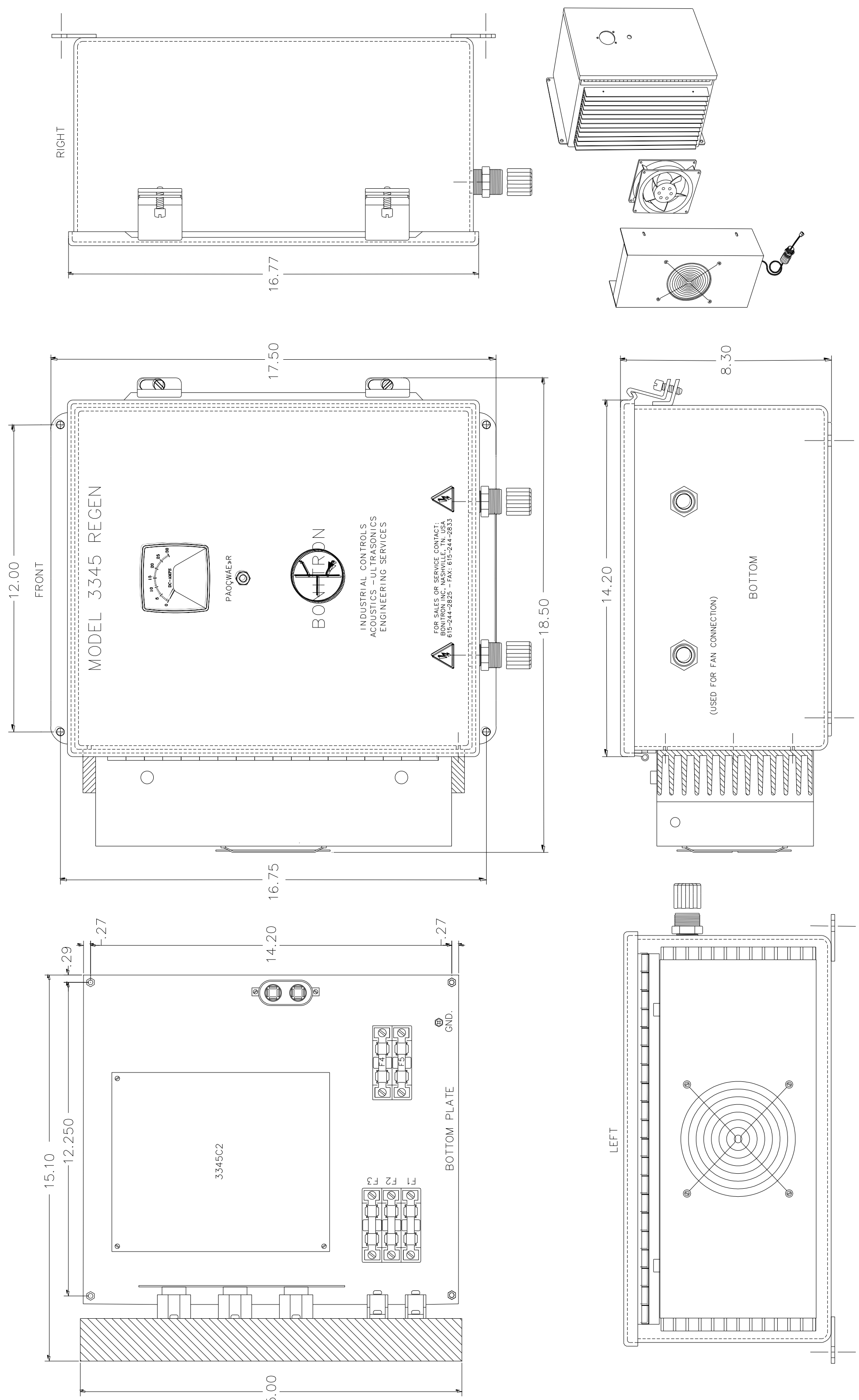
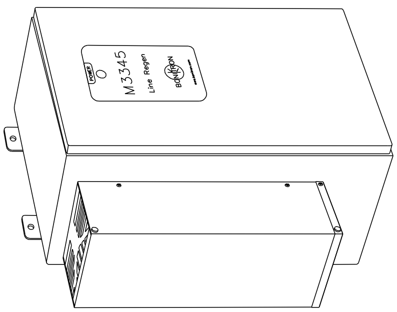
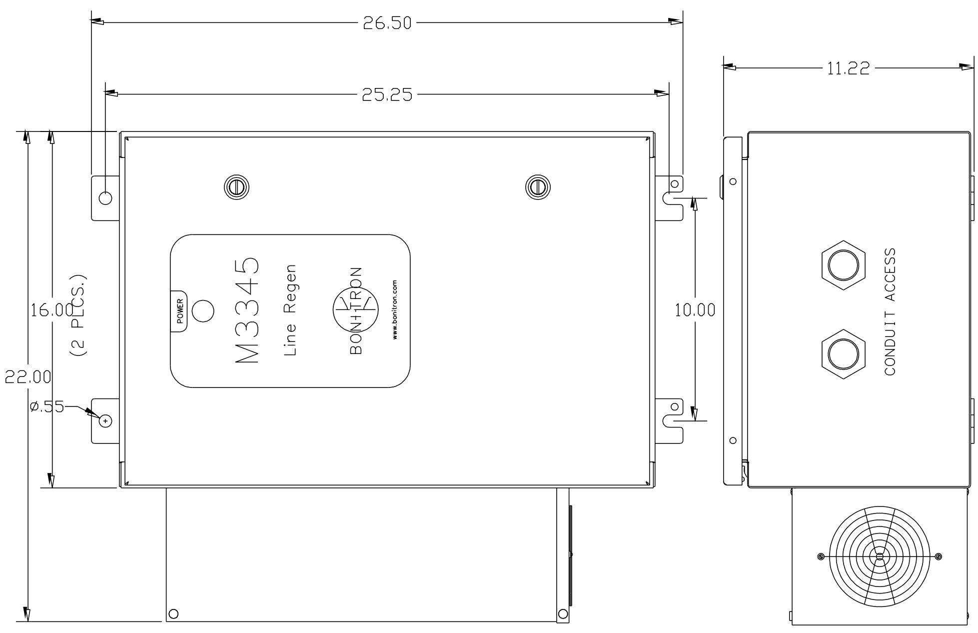


Figure 6-6: M3345 “C” Chassis Dimensional Outline





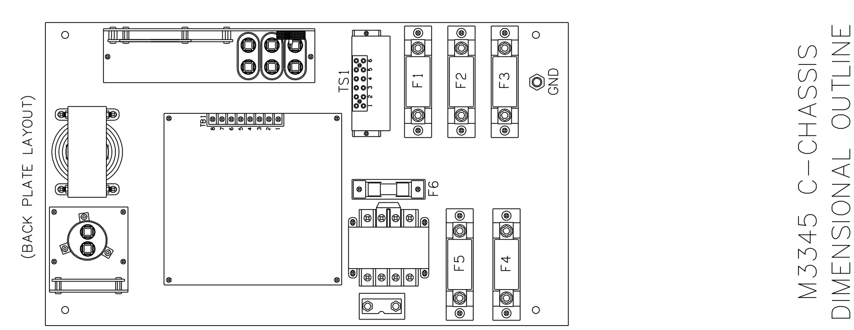
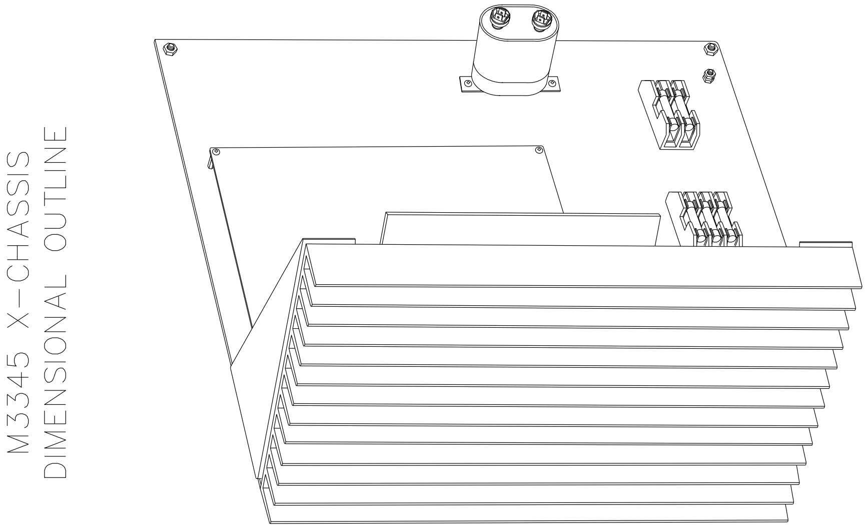


Figure 6-7: M3345 "X" Chassis Dimensional Outline



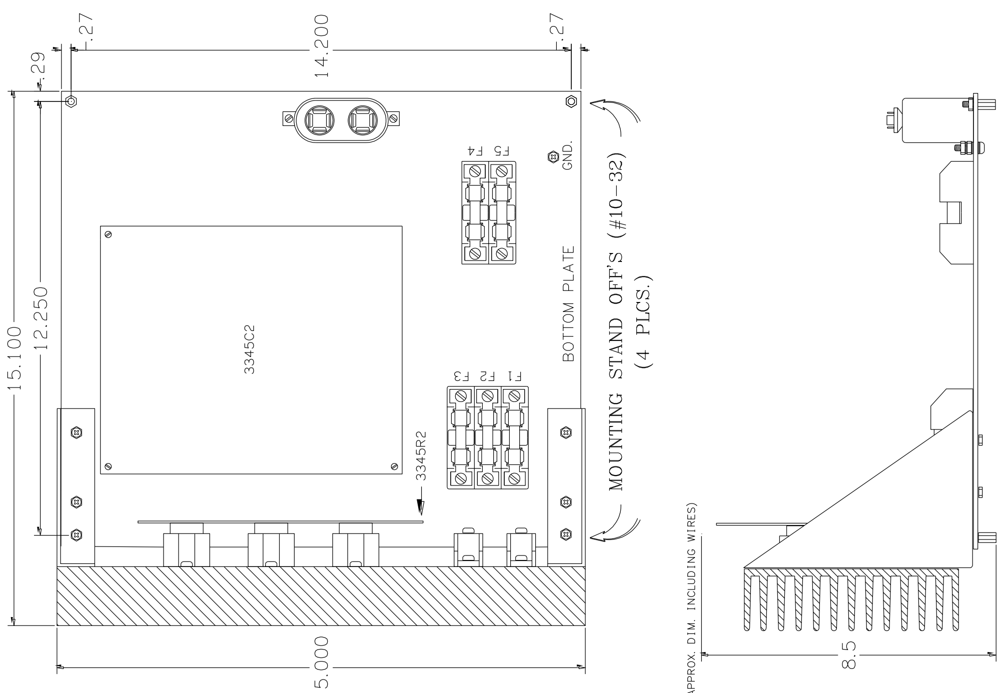


Figure 6-8: M3345 “X” Chassis with Fan Dimensional Outline

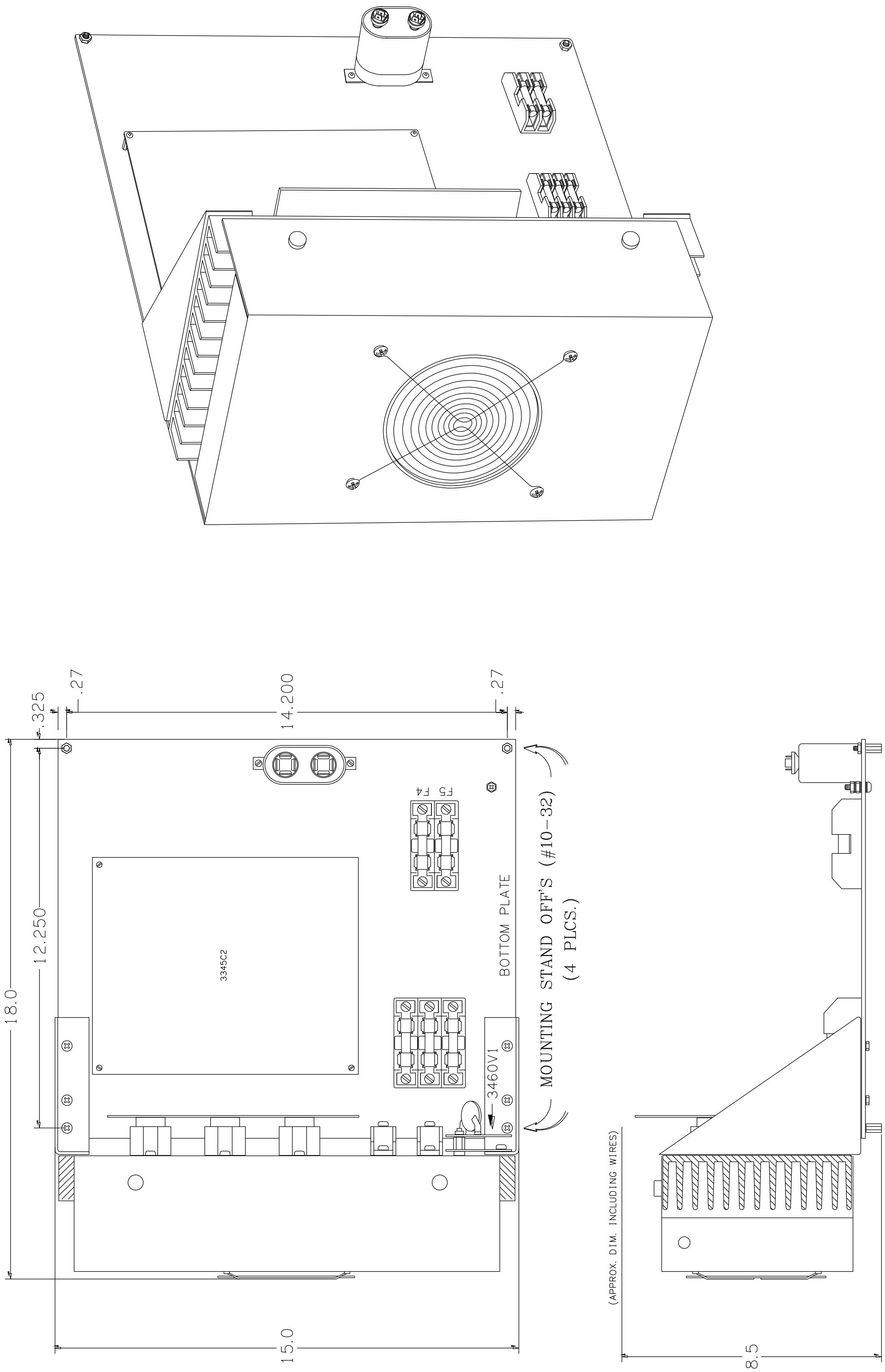


Figure 6-9: M3345 "Y" Chassis Dimensional Outline

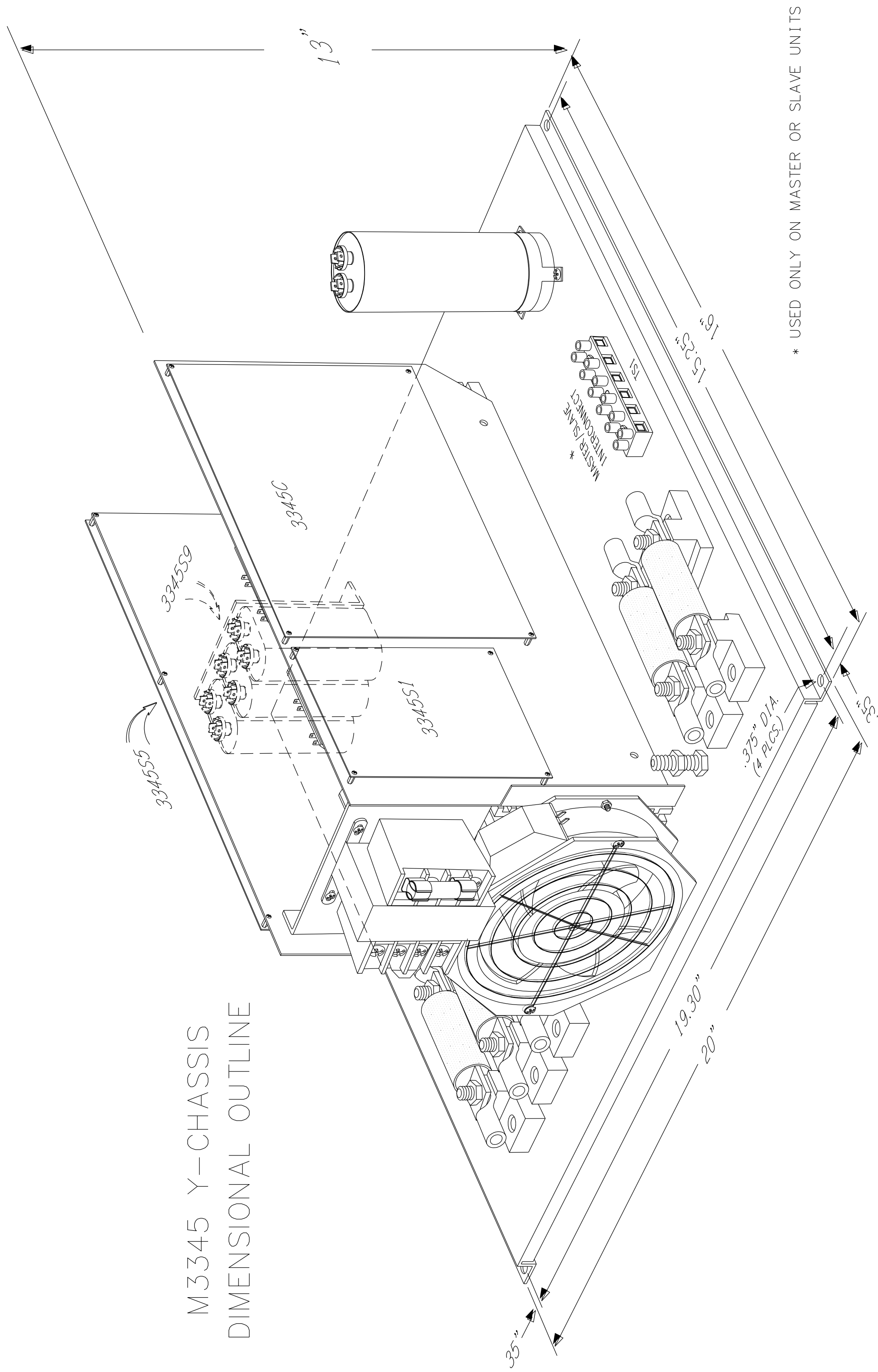
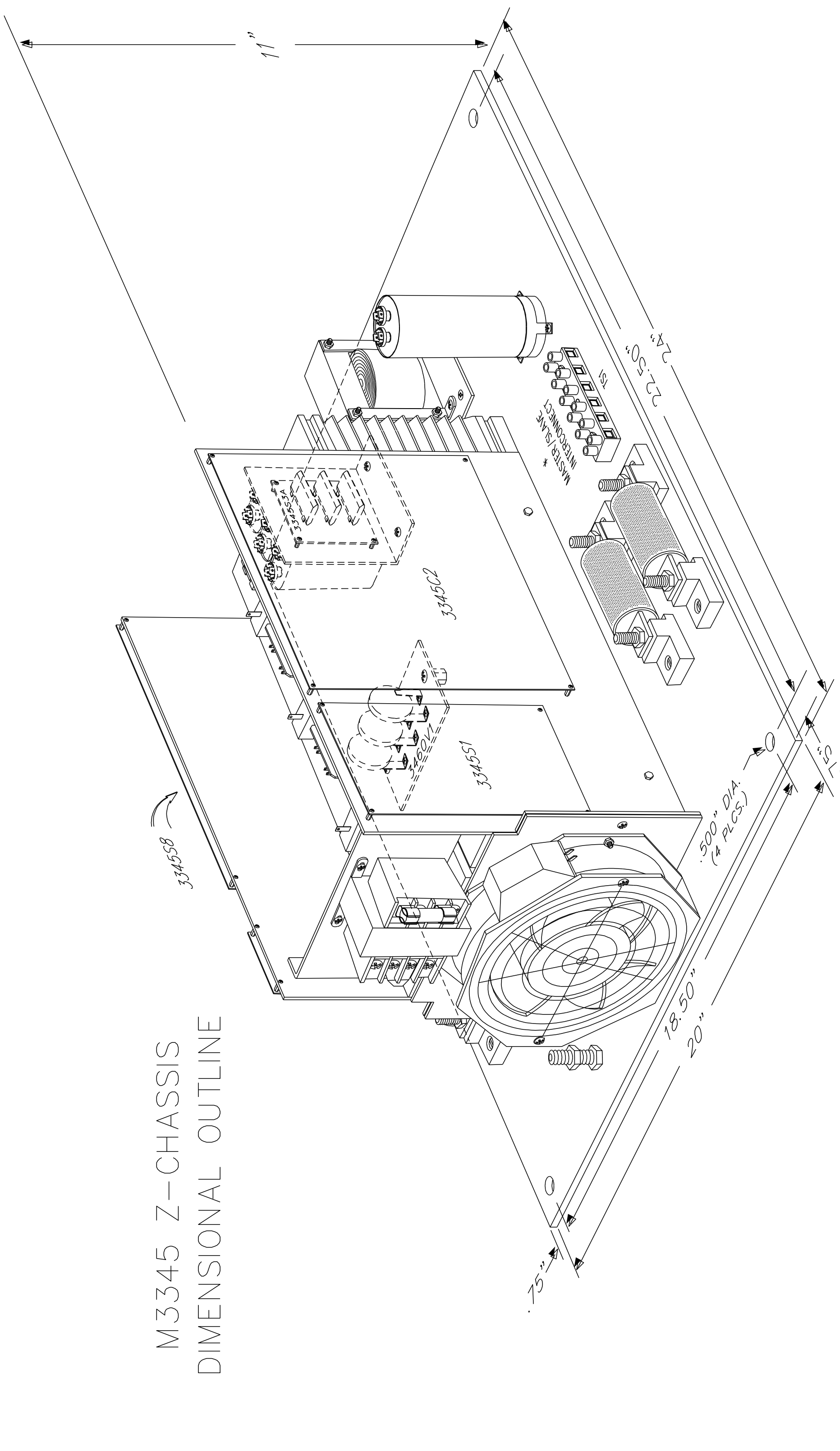
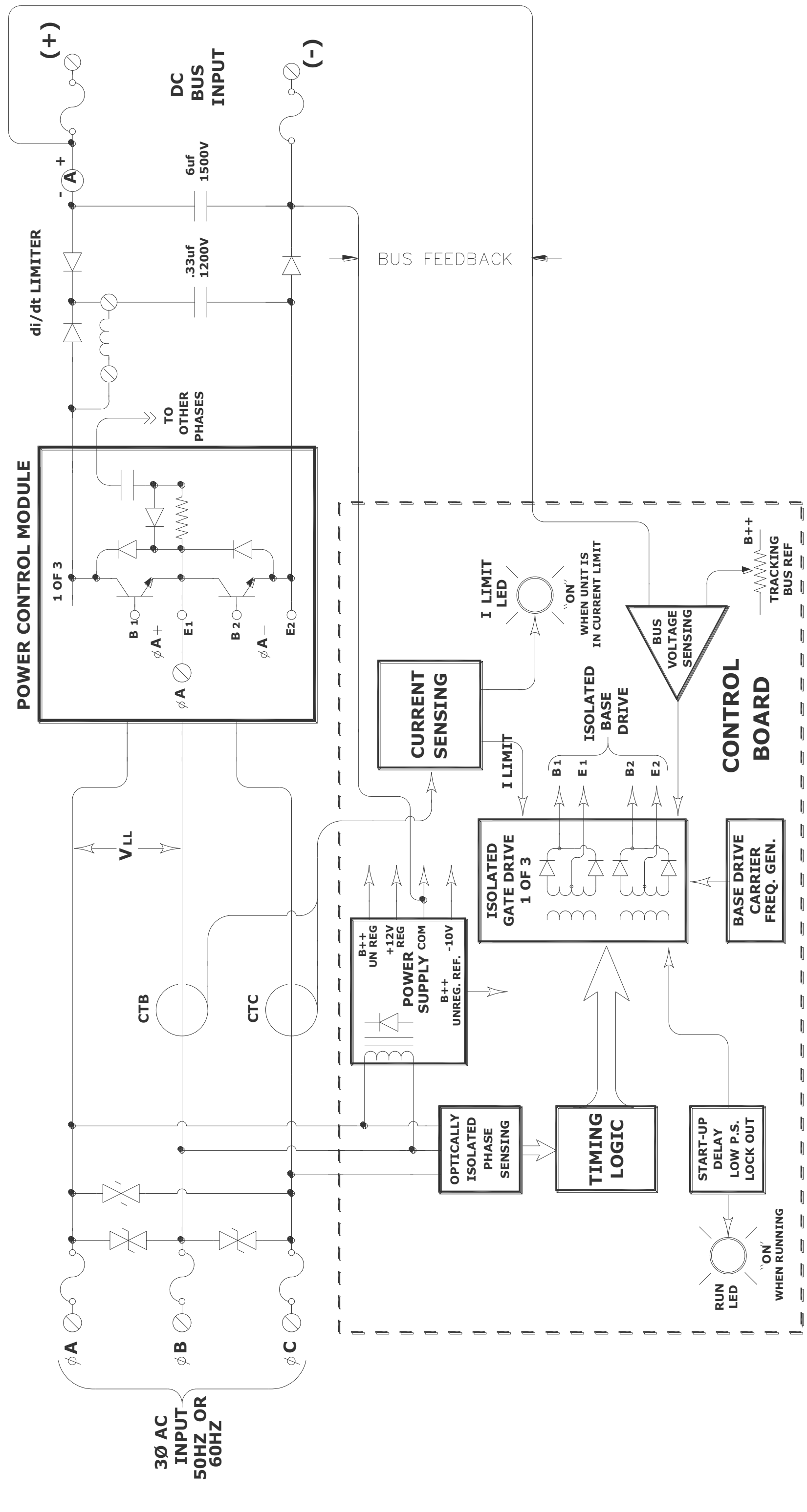


Figure 6-10: M3345 "Z" Chassis Dimensional Outline



6.6. BLOCK DIAGRAM

Figure 6-11: Line Regen Functional Block Diagram



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7. APPENDIX

7.1. APPLICATION NOTES

7.1.1. SIZING THE LINE REGENERATION CONTROL

Since the regeneration kit must direct energy from the DC bus back to the power system, it is sized for the amount of DC bus current which it must carry. To obtain the amount of DC bus current needed during deceleration; the load and motor inertias, desired change in RPM, and required stopping time must be known. With these application variables, the following calculations can be made to size the regeneration unit. Use the equation below to establish the torque required to decelerate or stop a rotating object.

$$T = \frac{(WK^2)\Delta N}{308t}$$

where:
- T = Torque required (lb-ft)
- WK^2 = Total inertia load to be decelerated (lb-ft)
- ΔN = Change in speed (rpm)
- t = Time to decelerate load (sec)

Calculate the horsepower required at maximum speed.

$$P = \frac{TN}{5250}$$

where:
- P = Power (Hp)
- T = Torque (lb-ft) (calculated above)
- N = Maximum shaft speed (rpm)

Determine the DC bus current rating required for the regeneration module.

IDC = P(1.2) for 460vac drives

or: IDC = P(2.4) for 230vac drives

where:
- P = Power (Hp) (calculated above)
- IDC = Regen Amps

7.1.2. CALCULATING ENERGY SAVINGS

The regeneration kit directs energy from the mechanical load to the power distribution line, where the energy is available to other connected loads. These units provide system energy savings over dynamic braking kits, because the net energy required from the distribution system is reduced by the excess energy. Additional savings also occur when there is a need to provide air conditioning with a DB kit and from reduced time spent stopping loads.

To calculate the savings; the regeneration duty cycle, the length of operation, the regen Hp, and the cost of energy must be known. With these application variables, the following calculation may be made to determine the cost savings:

$$\$S = P(0.746)(t/T)(D)(H)(\$kW)$$

where:	$S	=	Savings
	P	=	Power (Hp)
	D	=	Number of days
	H	=	Number of hours per day
	t/T	=	Percent on time
	$kW	=	Cost per kW

7.1.3. SAVINGS EXAMPLE

A 20 Amp, Model M3345-41SMF0, has been selected for use in braking a high inertia centrifuge with the following characteristics. Calculate the energy savings over a DB kit.

	P	=	20 Hp peak, 15 Hp average during deceleration
	D	=	365 days
	H	=	10 hours per day
	t/T	=	5(on)/15(total)
	$kW	=	$0.08 per kW
using:	$S	=	15(0.746)(5/15)(365)(10)($0.08))

Savings per year is:

$S	=	$1,089.16

Using the regen module, the centrifuge customer is also able to reduce the braking time from 5 minutes to 1.5 minutes. This results in a 30% increase in throughput for the machine and produces additional cost savings for the customer.

NOTES